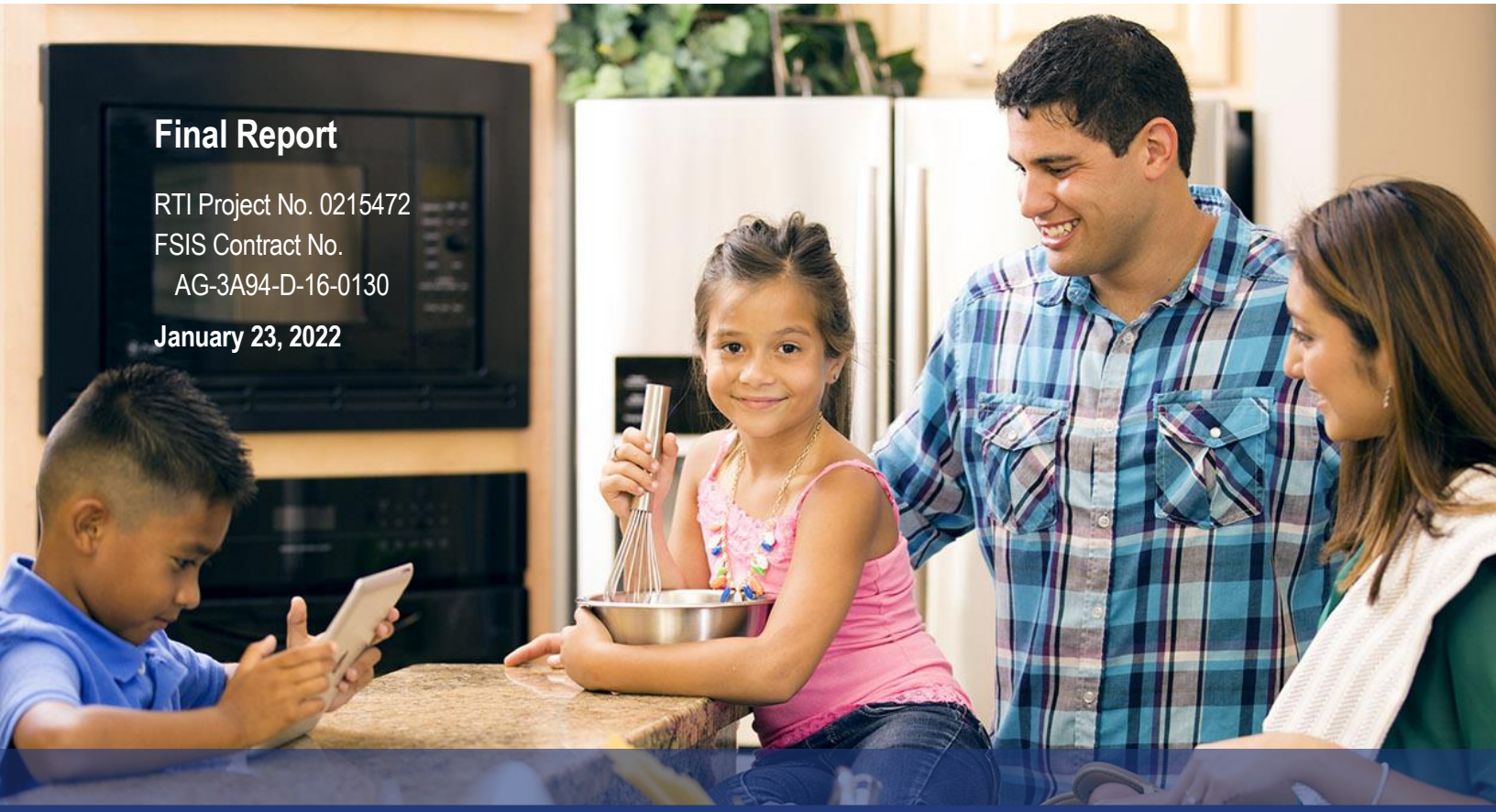

Final Report

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Food Safety Consumer Research Project: Meal Preparation Experiment on Grilling

Prepared For

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Executive Summary

The Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA) contracted with RTI International and its subcontractor North Carolina State University (NCSU) to conduct meal preparation experiments to evaluate consumer food handling behaviors in a test kitchen. The research team is conducting five separate iterations of meal preparation experiments to address a specific consumer behavior and to determine the effectiveness of a behavior change intervention. The meal preparation experiments are part of a larger 5-year annual study that also includes focus groups (two iterations) and web surveys (two iterations). This report describes the results of the fourth iteration of the meal preparation experiment.

RTI and NCSU conducted the study in a test kitchen facility located in Raleigh, North Carolina (Wake County), with three identical test kitchens. For this study, we explored the impact of including food safety instructions in recipes on participants' food safety practices. Participants were randomized to one of three conditions: the control group, recipes without food safety instructions; Treatment 1 (T1), recipes with food safety instructions; or Treatment 2 (T2), recipes with food safety instructions and a celebrity endorsement. A total of 200 people participated in the study (66 control, 66 T1, 68 T2). Food safety information was formatted using the Partnership for Food Safety Education's Safe Recipe Style Guide[1] and included instructions on washing hands at the beginning of cooking and after touching uncooked ground beef, using a food thermometer to check for doneness, cleaning and sanitizing surfaces and utensils after touching uncooked ground beef, and washing the apple and carrot by rubbing under cold water. For the outcomes of interest, we conducted statistical testing for the difference between the control vs. T1, control vs. T2, and T1 vs. T2.

In each test kitchen, eight cameras recorded participants' actions at various locations throughout the kitchen and recorded the meal preparation from beginning to end. Participants in the control and treatment groups were observed while grilling bratwurst and hamburgers (inoculated with harmless traceable nonpathogenic *E. coli* strain DH5-Alpha) and preparing a ready-to-eat (RTE) salad (bagged lettuce, carrots, and apples) to determine whether they used a food thermometer, adhered to recommended handwashing practices, safely prepared the RTE salad, and safely handled and stored uncooked ground beef from a chub. Following meal preparation and participants' cleaning and/or sanitizing of the kitchen, the study team collected microbiological samples from surfaces and lettuce from the prepared RTE salad and analyzed the samples for prevalence and level of DH5-Alpha. Participants participated in a post-observation interview to collect information on their usual food preparation practices.

[1] https://www.saferecipeguide.org/

ES.1 Key Findings

The key findings from the study are summarized below.

Food Thermometer Use

- Thermometer use was significantly higher in the two treatment groups (95% for T1 and 96% for T2) when compared with the control group (55%) for determining doneness of bratwurst.
- Thermometer use was significantly higher in the two treatment groups (95% for T1 and 99% for T2) when compared with the control group (58%) for determining doneness of hamburgers.
- Among participants in all groups, most participants who used a thermometer checked the doneness of the two hamburgers and all five bratwurst.
- Among participants using a thermometer, most participants failed to insert the thermometer in the proper location when checking the doneness of the hamburgers and bratwurst.
- Comparing thermometer use among control group participants for Years 1 through 4 of the study, thermometer use varied by the type of product cooked. Thermometer use was significantly higher for hamburgers (58%) compared with turkey burgers (34%).

Handwashing

- Handwashing attempts before meal preparation were significantly higher in the two treatment groups (62% for T1 and 65% for T2) when compared with the control group (44%).
- There was not a statistically significant difference in the rate of handwashing attempts between the three groups for events requiring handwashing during meal preparation.
- As in Years 1 through 3, few handwashing attempts included all steps necessary to be considered an adequate handwashing event as defined by the Centers for Disease Control and Prevention's recommended steps, and the most documented reason for not successfully washing hands was failing to rub hands with soap for at least 20 seconds.
- For handwashing before meal preparation, the rate of attempting handwashing (44%) was significantly lower compared with rates observed for study Year 2 (74%) and Year 3 (71%) among control group participants.[2] We speculate that the lower rate for Year 4 may be because participants used the hand sanitizer station upon arrival, which was not present in prior years, as a COVID-19 precaution. Other reasons are possible, such as differences in the characteristics of the study sample and social distancing measures during the participant introduction to the test kitchen, which led them to touch meal preparation surfaces (e.g., drawers/cabinets), thus commencing meal preparation before washing their hands. Additional analysis is needed to understand why the rates are different.

[2] For Year 1, data were not available by when handwashing took place (i.e., before the start of or during meal preparation).

Handling, Preparation, and Storage of Chub/Ground Beef

- Most participants placed the chub on a cutting board or plate to prepare the hamburgers or dumped the ground beef into a bowl without letting the ground beef or chub packaging touch a surface. Some participants (15 to 20% depending on study group) prepared the ground beef directly on the counter, which is not recommended.
- Immediately after handling the chub, 31% of control group participants, 53% of T1 participants, and 46% of T2 participants attempted cleaning/sanitizing the surface used to prepare the uncooked ground beef from the chub; the difference between the control group and T1 was statistically significant, but not between the control group and T2.
- Most participants stored the uncooked ground beef from the chub in the refrigerator (instead of placing in freezer). Few participants labeled the package.

Cross-contamination and Microbiological Analysis

- Across all participants, the surface most often contaminated was the sink basin (28% of participants). The rate of contamination for the spice containers was 12%. Rates of contamination were relatively low for the cupboard handle (8%) and the counter area where the chub was opened (3%).
- Among participants handwashing the plate or cutting board used to prepare the hamburgers from the chub, 32% of participants did not thoroughly wash the plate/cutting board (i.e., it was contaminated with the surrogate).
- Across all participants, the prevalence for contamination on the salad lettuce was 17%.
- For the sink basin, the prevalence rate for contamination was higher for the control group (32%) compared with T1 (17%). Prevalence rates for the other surfaces and the salad lettuce were not significantly different between the control group and the two treatment groups.

Washing Produce

- Rates of properly washing the carrot for the RTE salad were higher in the treatment groups (84% for T1 and 75% for T2) than the control group (71%); however, the differences were not statistically significant.
- Rates of properly washing the apple for the RTE salad were higher in the treatment groups (83% for T1 and 79% for T2) than the control group (72%); however, the differences were not statistically significant.
- For both the carrot and apple, about 40% of control group participants did not attempt washing, whereas nearly all T1 and T2 participants attempted washing, although some failed to rub it with their hands, so the attempt was unsuccessful.
- Most participants in all three groups did not wash the bagged lettuce as recommended.

ES.2 Implications for OPACE Outreach Efforts

The key implications for OPACE outreach efforts based on the study results are summarized below:

- ***Inclusion of food safety instructions positively affected some food safety practices.*** The study results suggest that the food safety instructions included in the recipes positively affected using the thermometer, attempting handwashing before meal preparation, and attempting cleaning/sanitizing immediately after handling the chub but did *not* affect attempting handwashing during meal preparation and properly washing the carrot and apple. Lower rates of cross-contamination were also found for certain kitchen surfaces. In the post-observation interviews with treatment group participants, many participants reported using recipes when cooking at home, and most reported that they noticed the food safety instructions in the recipes provided for the meal preparation experiment.

- ***The addition of a celebrity chef endorsement for food safety instructions in recipes did not influence food safety practices.*** Recognition of the celebrity chef (Kenji Lopez-Alt) featured in T2 was low (15%), which likely led to the lack of statistically significant differences between T1 and T2 for the behaviors of interest. Although most T2 participants said they trust celebrity chefs in general, only about a third agreed they would follow food safety instructions because a celebrity chef endorsed them. These findings suggest that the addition of a celebrity chef endorsement for food safety instructions in recipes may not influence consumers' food safety behaviors and that inclusion of food safety instructions alone may be sufficient to motivate behavior change.

- ***Providing consumers with information on food safety practices at the point of use (i.e., during meal preparation) may help facilitate behavior change.*** Prompting consumers with food safety instructions at the time of meal preparation and as part of the recipe positions a consumer to adhere to food safety instructions as part of the process, even if it is not something they normally do. The Partnership for Food Safety Education's Food Safety Style Guide could also be used as a reference point for media organizations when developing news segments about food safety and include examples on how to handle food safely to help prevent foodborne illness.

1. Introduction

This report describes the study methods and presents the results from a meal preparation study related to grilling bratwurst and hamburgers on an indoor grill and handling and storage of uncooked ground beef from a chub conducted as part of the Food Safety Consumer Research Project (FSCRP). The study, conducted in test kitchens, used an experimental design to measure consumers' adherence to recommended food safety practices between participants who received an educational intervention and those who did not. The grilling study is the fourth of five iterations of a meal preparation experiment in which consumers are observed while preparing meat and poultry products regulated by the U.S. Department of Agriculture's (USDA's) Food Safety and Inspection Service (FSIS). This report details the study design, data collection procedures, and data analysis approach and presents the results of the Year 4 meal preparation experiment. Additionally, the report compares key behavioral outcomes for Years 1 through 4 of the study.

1.1 Background and Project Overview

USDA FSIS' Office of Public Affairs and Consumer Education (OPACE) ensures that all segments of the farm-to-table chain receive valuable food safety information. The consumer education programs developed by OPACE's Food Safety Education Staff inform the public on how to safely handle, prepare, and store meat, poultry, and egg products to minimize the incidence of foodborne illness.

OPACE strives to continuously increase consumer awareness of recommended food safety practices with the intent to improve food handling behaviors at home. OPACE shares its messages through consumer education campaigns, social media, the Meat and Poultry Hotline and Ask USDA (an online database of frequently asked food safety questions), the FSIS web site, FoodSafety.gov, publications, and events. These messages are focused on the four core food safety behaviors: clean, separate, cook, and chill. Additionally, OPACE's public education and outreach initiatives reach vulnerable and underserved populations.

By testing new consumer messaging and tailoring existing messaging, FSIS can help ensure that it is effectively communicating with the public and promoting behavior change with a goal of improving consumer food safety practices. FSIS contracted with RTI International to conduct consumer research over a 5-year period, fiscal year 2017 through fiscal year 2022. RTI is teaming with researchers at North Carolina State University (NCSU) to conduct the project. This behavioral research will include observation studies of food preparation in test kitchens using an experimental design (five iterations), focus group studies (two iterations), and web surveys (two iterations). Each iteration of each data collection activity will address different research questions and use a different sample of consumers. This research will provide insight into the effect FSIS consumer outreach activities have on consumers' food

safety behaviors. FSIS will use the results of this research to enhance messaging and accompanying materials to improve food safety behaviors of consumers.

1.2 Objectives of Grilling Meal Preparation Experiment

Previous research suggests that self-reported data collected through surveys on consumers' food safety practices may be unreliable because consumers tend to overreport their behavior (e.g., simply rinsing their hands instead of washing with soap and water for 20 seconds as recommended) (Redmond & Griffith, 2003). Because of this limitation, observation is often a preferred approach for collecting information on consumers' food safety practices.

Studies that have used direct observation of consumer food handling have reported that many consumers commit errors during preparation and self-report actions that are different from the ones they took (Anderson et al., 2004; DeDonder et al., 2009; Jay, Comar, & Govenlock, 1999; Kendall et al., 2004; Redmond, Griffith, Slader, & Humphrey, 2004). The results of the meal preparation experiments will help FSIS assess adherence to the four recommended food safety behaviors of clean, separate, cook, and chill; determine whether food safety messaging focused on those behaviors affects consumers' safe food handling behaviors; and determine whether consumers introduce cross-contamination during food preparation for certain raw meat and poultry products.

Each iteration of the meal preparation experiment addresses a specific consumer behavior. The fourth iteration examined thermometer use, handwashing practices, and handling and storage of uncooked ground beef from a chub. For this study, we explored the impact of including food safety instructions in recipes on participants' food safety practices. Participants were randomized to one of three conditions: the control group, recipes without food safety instructions; Treatment 1 (T1), recipes with food safety instructions; or Treatment 2 (T2), recipes with food safety instructions and a celebrity endorsement. Participants were asked to grill bratwurst and hamburgers and prepare a ready-to-eat (RTE) salad (bagged lettuce, carrots, and apples). The study also assessed pathogen transfer during meal preparation and included the collection of microbiological samples from lettuce (from the prepared RTE salad) and kitchen surfaces. We observed participants throughout meal preparation to determine whether they used a food thermometer, adhered to recommended handwashing practices, safely prepared the RTE salad, and safely handled and stored uncooked ground beef from a chub. Post-observation interviews collected information on participants' reasons for following or not following recommended food safety practices during the meal preparation and their response to the intervention (treatment groups). Additionally, to provide information to the Food and Drug Administration (FDA), 50 additional participants prepared guacamole to examine preparation of an RTE product using avocado and cilantro; these data were not included as part of the experimental study and will be described in a separate memorandum.

Table 1-1 lists the study's research questions, data sources, and the corresponding section of this report with the results of the analysis conducted to address each research question.

Table 1–1. Research Questions, Data Sources, and Location of Results in Report

Research Questions	Data Source	Location in Report
Is the rate of thermometer use on the bratwurst and hamburgers higher for T1 compared with the control group? Is the rate higher for T2 compared with the control group? Is the rate for T2 higher compared with T1?	Observations	Section 3.2; Table 3-4
Is the mean number of items (bratwurst or hamburgers) checked for doneness higher for T1 compared with the control group? Is the mean number higher for T2 compared with the control group? Is the mean number higher for T2 compared with T1?	Observations	Section 3.2; Table 3-4
What methods are used to determine doneness of bratwurst and hamburgers in lieu of a food thermometer for the control and treatment groups?	Observations, post-observation interviews	Section 3.2; Table 3-4
Is the rate of handwashing attempts higher for T1 compared with the control group? Is the rate higher for T2 compared with the control group? Is the rate for T2 higher compared with T1?	Observations	Section 3.3; Tables 3-7, 3-8
Is the rate of cleaning/sanitizing attempts higher for T1 compared with the control group? Is the rate higher for T2 compared with the control group? Is the rate for T2 higher compared with T1?	Observations	Section 3.4; Table 3-11
How do participants handle and store uncooked ground beef from a chub to be prepared later?	Observations, post-observation interviews	Section 3.4; Tables 3-12, 3-13, 3-14
Is the rate of successfully washing apples and carrots higher for T1 compared with the control group? Is the rate higher for T2 compared with the control group? Is the rate for T2 higher compared with T1? Do participants wash commercially bagged lettuce and do the rates vary by group?	Observations	Section 3.5; Table 3-15
Is the prevalence of contamination lower for T1 compared with the control group? Is the prevalence lower for T2 compared with the control group? Is the prevalence for T2 lower compared with T1?	Microbiological sampling data	Section 3.6; Table 3-16

(continued)

Table 1–1. Research Questions, Data Sources, and Location of Results in Report (continued)

Research Questions	Data Source	Location in Report
Did participants recall the food safety instructions? If so, did participants self-report that the instructions influenced food preparation? (T1 and T2)	Post-observation interviews	Section 3.7; Table 3-17
Did participants self-report that food safety messaging from a celebrity chef influenced food preparation? (T2 only)	Post-observation interviews	Section 3.7; Table 3-18
What differences are there between key behavioral outcomes for Years 1–4 of the study?	Observation	Section 3.2, Table 3-6; Section 3.3, Table 3-10

1.3 Organization of Report

This report is organized as follows:

- Section 2 describes the research design, data collection procedures, and analysis approach.
- Section 3 presents and discusses the results of the study for thermometer use, handwashing compliance, and other behaviors, as well as participants' responses to the intervention.
- Section 4 concludes the report by summarizing the key findings and discussing the implications of the study results for OPACE's consumer food safety education and outreach efforts.

The final report includes the following appendixes:

- Appendix A: Recipes
- Appendix B: Observation Script
- Appendix C: List of Equipment Provided in Each Test Kitchen
- Appendix D: Microbiological Methods
- Appendix E: Post-observation Interview Guide
- Appendix F: Screening Questionnaire
- Appendix G: Observation Rubric for Coding Participant Actions in the Kitchen

2. Study Methods

This section describes the methodology for the meal preparation experiment, the recruitment procedures, and the approach for coding and analyzing the observations and post-interview data. The Office of Management and Budget (OMB control number 0583-0169, expiration date 8/31/2023) and NCSU's Institutional Review Board (IRB) approved the study protocol and materials.

2.1 Meal Preparation Experiment Methodology

2.1.1 Research Design

The fourth iteration of the meal preparation experiment focused on the food safety behavior of "cook," specifically whether participants used a food thermometer when grilling bratwurst and hamburgers. The study also examined whether participants followed recommended practices for repackaging remaining uncooked ground beef from a chub, proper handwashing, and safe preparation of an RTE salad. Study participants were adult individuals who self-reported cooking ground beef burgers on an outdoor grill within the past 6 months.

The intervention was incorporated into recipes provided to participants. The study had two intervention groups: (1) T1, recipe included food safety instructions and (2) T2, recipe included the same food safety instructions and an endorsement by a celebrity chef, J. Kenji López-Alt, such as "Kenji's Spicy Burgers and Brats" (see Appendix A for a copy of each version of the recipes). Food safety information was formatted using the Partnership for Food Safety Education's (PFSE's) Safe Recipe Style Guide[3] (see sidebar). The control group's recipes did not include food safety instructions or reference to a celebrity chef. Eligible participants were randomly assigned to the control group (no exposure) or one of the two treatment (intervention) groups. The purpose of the experimental intervention was to evaluate whether including food safety instructions in recipes leads to greater adherence to recommended safe food handling practices compared with the control group (T1 vs. control), whether including food safety instructions in recipes and a celebrity chef endorsement leads to greater adherence to recommended safe food handling practices compared with the control group (T2 vs. control), and whether including food safety

Food Safety Instructions Included in Recipes for the Two Treatment Groups

- Wash hands with soap and water [included at the beginning of each recipe].
- Wash hands with soap and water after handling uncooked ground beef.
- Clean and then sanitize the counter and utensils after touching uncooked ground beef.
- Gently rub apples/carrots under cold running water.
- Grill burgers and brats until internal temperature reaches 160°F on food thermometer.

[3] https://www.saferecipeguide.org/

instructions in recipes and a celebrity endorsement leads to greater adherence to recommended safe food handling practices than food safety information alone (T2 vs. T1). Maughan et al. (2016) conducted a similar experiment using a recipe modified with safe food handling instructions to promote safe food handling behaviors for participants when preparing a baked chicken breast and a ground turkey patty and observed for handwashing and thermometer use behaviors. Adherence to safe handling behaviors between participants exposed to food safety instructions in the recipe and those not exposed to food safety instructions ranged from 24 to 66%.

The COVID-19 pandemic and subsequent requirements for social distancing and other precautions to ensure the safety of participants and research staff limited the number of participant appointments that could be scheduled each day and the number of microbiological samples that could be processed each day to a total of 200 participants. We used a balanced design with 66 participants randomly assigned to each study condition.

2.1.2 Study Procedures

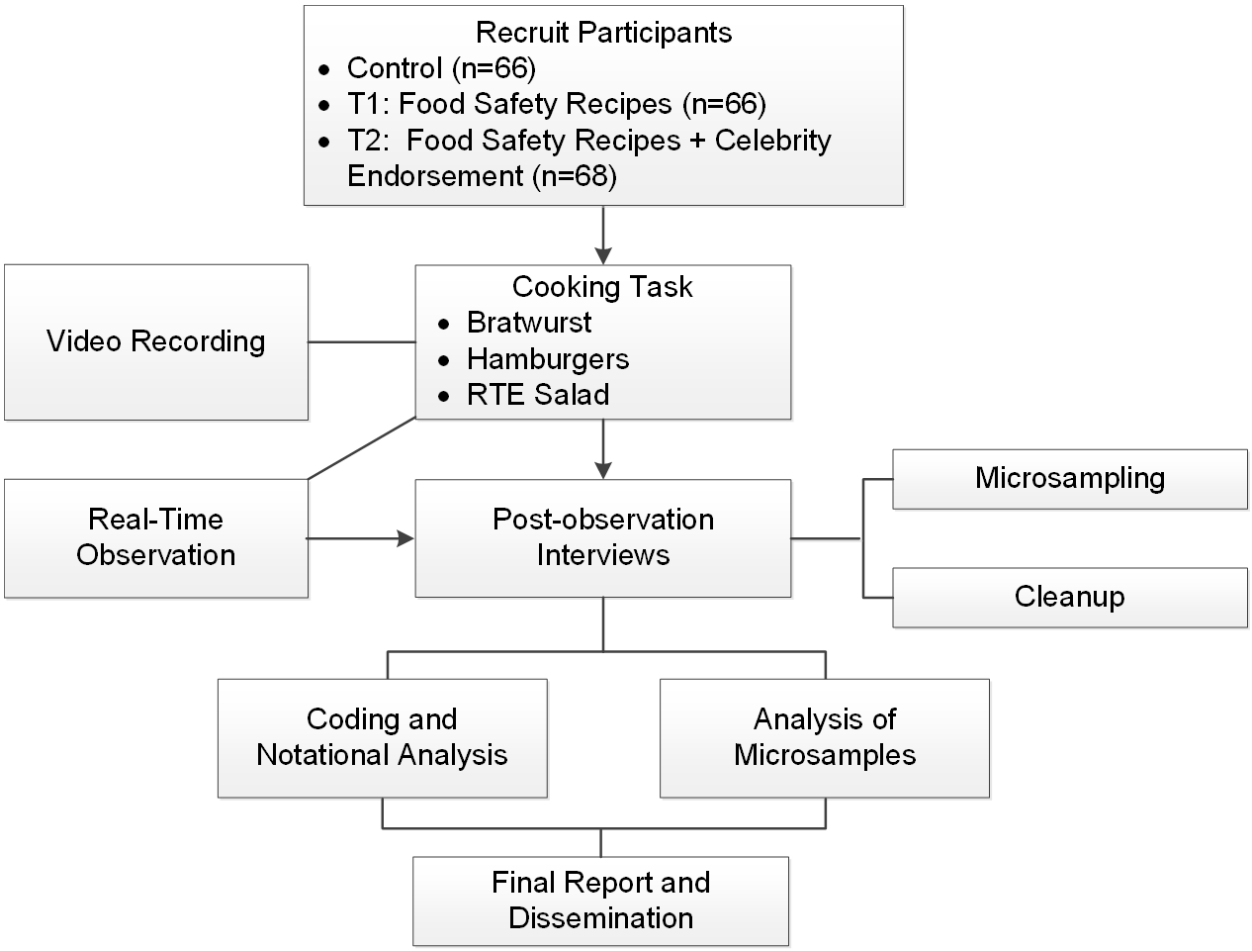
Figure 2-1 summarizes the study procedures. We conducted the study in a test kitchen facility located in Raleigh, North Carolina (Wake County) with three identical test kitchens. Each test kitchen has a sink, refrigerator, and stove/oven and was stocked with the same meal preparation equipment (dishes, knives, utensils, cutting boards, thermometer). In each test kitchen, eight cameras recorded participants' actions at various locations throughout the kitchen and recorded the meal preparation from beginning to end. We implemented procedures to mitigate risks of COVID-19 to participants and research staff.[4]

We used convenience sampling to recruit participants using a variety of approaches. Section 2.2 describes the participant screening criteria and recruitment procedures. Participants received a $75 gift card and gift (food thermometer, mentioned after the completion of the research) for taking part in the study, which could take up to 90 minutes. Participant recruitment began November 10, 2020. We conducted observations beginning on December 2, 2020, and ending May 14, 2021.

[4] To mitigate risks of COVID-19 to participants and research staff, the following safety precautions were implemented: access to the kitchens was limited; participants were scheduled at times that did not overlap; waiting room furniture was spaced 6 feet apart; floor markers were placed in the test kitchens to ensure 6 feet of distance between researcher and observer during introduction to the kitchen equipment; all researchers and participants wore face masks during the entire observation; researchers wore gloves when swabbing surfaces in the kitchen; kitchen equipment and surfaces were sanitized before each observation (three rounds of sanitizing); high-touch surfaces in the observation room were wiped down with disinfecting wipes after each observation; and researchers adhered to strict personal hygiene guidelines, including washing hands following Centers for Disease Control and Prevention (CDC) guidelines and use of hand sanitizer while in the observation room. In addition, hand sanitizer stations were located at the entrances to the building and test kitchen; participants were not required to use them.

We randomly assigned participants to the control or one of the treatment groups when the appointment was scheduled with the goal of 66 participants in each group. The study team scheduled appointments at the test kitchen location based on kitchen availability with observations scheduled during the week, on weekends, and at different times of day (e.g., morning, afternoon, and evening). Once participants arrived at the test kitchen, a study team member greeted them and instructed them to read and sign an informed consent form.

Figure 2-1. Study Procedures for Meal Preparation Experiment on Grilling Bratwurst and Hamburgers



Using a script to ensure consistency in delivery (see Appendix B), the study team member described what participants could expect during the study. Initially, we told participants the purpose of the study was recipe testing. Consistent with the approach used in other observation studies, we informed participants of the real purpose of the study following the post-observation interview and why it was important from a scientific perspective to inform

them after the study was completed[5] (Chapman, Eversley, Fillion, MacLaurin, & Powell, 2010; DeDonder et al., 2009).

A study team member instructed participants to grill the package of bratwurst and two hamburgers on the grill provided. Participants were provided with a laminated recipe card (see Appendix A) for preparing the bratwurst and hamburgers, as well as a side salad, and told the location of the ingredients. A study team member pointed out that cabinets contained utensils, dishes, pans, and cleaning supplies and were labeled accordingly. Appendix C provides a list of equipment provided in each test kitchen and a picture of one of the test kitchens. Participants were instructed to prepare the bratwurst and hamburgers first. Using this approach, it would reduce the time required in the kitchen and provide the opportunity for cross-contamination. Participants were also instructed to prepare only half of the ground beef and to repackage the remaining ground beef from the chub as they would at home, and the locations of common materials for repackaging were shown (plastic/freezer bags, plastic containers, plastic wrap, aluminum foil). Participants were asked to clean up as they would at home once they were done cooking.

In the second year of the annual FSCRP study, the NCSU microbiology team provided the FSIS' Office of Public Health Science (OPHS) with scientific justification for using a nonpathogenic *Escherichia coli* strain, tagged with green fluorescent protein (*E. coli* DH5-Alpha), as a surrogate for pathogenic *Salmonella* in whole chicken pieces and OPHS approved the use of this surrogate. For this study, we inoculated ground beef packaged in chub-like bags and used the same nonpathogenic *E. coli* strain, as approved by OPHS, as a surrogate for pathogenic *E. coli*, such as O157, found in ground beef.

The use of nonpathogenic *E. coli* strains as surrogates for pathogenic *E. coli* in beef is well documented in the literature (Cabrera-Diaz et al., 2016; Ingham et al., 2016; Keeling et al., 2009; Vasan et al., 2016) and reviewed in Hu and Gurtler (2017). In these studies, no significant differences were observed between pathogenic *E. coli* and fluorescent protein–marked nonpathogenic *E. coli* for growth parameters, acid resistance, thermal resistance, cell surface hydrophobicity, attachment to beef carcass surfaces (Cabrera-Diaz et al., 2016) and for freezing, refrigeration, fermentation, and thermal inactivation (Keeling et al*.,* 2009). It can be reasonably assumed from the literature that the use of nonpathogenic fluorescent protein-marked *E. coli* surrogate (*E. coli* DH5-Alpha) will provide representative information as to how a pathogenic *E. coli* strain would behave during meal preparation involving ground beef packaged in chubs. The inoculated chubs were packaged in a 1-pound package.

We cleaned and sanitized all accessible kitchen surfaces (e.g., counters, drawer pulls, stove top) and appliances after each participant to ensure that any potentially remaining *E. coli* DH5-Alpha contamination was removed before the next participant entered the kitchen.

[5] After being informed of the study's purpose, participants could opt out of the study and have their data excluded from the analysis. No participants chose to opt out of the study.

Additional cleaning protocols were put into place to reduce the risk of COVID-19 transmission to participants and research staff: Before the first observation of the day, all counter and stove surfaces, refrigerator handles and shelves, trash can lids, sinks, and sink faucets were sanitized using bleach/disinfecting wipes. After each observation, research staff conducted this cleaning and disinfecting procedure for three rounds of cleaning and sanitizing. The entry (main) door handle and the door handles of all test kitchens and the observation room were wiped down three times after each observation. Meal preparation items (e.g., knives, utensils, plates) were cleaned and sanitized in the dishwasher. Items that could not be placed in the dishwasher were cleaned and disinfected using either a disinfectant spray or wiped three times with a disinfecting wipe after each observation.

To confirm effective decontamination of the kitchen between participants, one cleaning validation surface swab was taken before a participant began preparing the meal. A total of six surface samples and one lettuce sample were taken for each observation, resulting in seven total samples per meal preparation event. An NCSU lab team member processed the swabs to determine the presence and concentration of the *E. coli* DH5-Alpha. Appendix D provides a complete description of the selection of the surrogate and the microbiology methodology.

Supplementing the observations, we conducted semistructured post-observation interviews to provide insight into participants' views, opinions, and experiences during the meal preparation experiment. Interviews lasted approximately 20 minutes (see Appendix E for the post-observation interview guide). The total time for the observation and interview was approximately 90 minutes.

2.1.3 Pilot Testing

Before initiating the full-scale data collection, we conducted a pilot study to test the study materials, procedures, and the time allotted for data collection. We conducted the pilot with two subjects recruited through mutual acquaintances of NCSU staff working on the project. Based on the pilot observations, we updated the procedures by instructing participants to cook the bratwurst and hamburgers first, adding additional information to the T2 recipes about the celebrity chef, and providing additional clarification about other items in the recipes. The post-observation interview guide was simplified and clarified, and questions were added to ask whether COVID-19 has influenced participant handwashing practices. The pilot study also helped finalize the sampling locations throughout the kitchen. Following the pilot study, NCSU submitted their COVID-19 safety protocols to the IRB, which was required to ensure research staff and participant safety.

2.2 Recruitment Procedures

The study team used convenience sampling with quotas to obtain a mix of participants with regard to race, ethnicity, age, education level, and presence of children in the household.

We recruited participants using social media outlets (e.g., Facebook, Twitter) and online advertising platforms (e.g., Craigslist).

Participants had to meet specific inclusion and exclusion criteria. The inclusion criteria were as follows:

- are 18 to 64 years old (excluded individuals 65 years or older because of increased COVID-19 risk)
- speak English[6]
- have cooked ground beef hamburgers on an outdoor grill within the past 6 months

The exclusion criteria were as follows:

- have cooked or worked professionally in a food preparation setting in the past 5 years
- have received any type of food safety training, such as ServSafe, in the past 5 years
- participated in a study about cooking within the past 3 years

Recruitment materials directed prospective participants to call or email the study team to be screened for eligibility or to a web link that hosted the screening questionnaire (see Appendix F). For participants screened by phone, we invited eligible participants to participate in the study and scheduled an appointment during the screening call. For participants who completed the web-based screener, we contacted eligible participants by phone, invited them to participate in the study, and scheduled an appointment. Appointments were scheduled during work hours, evenings, and weekends to allow for a broad participant pool. After an appointment was scheduled, we sent one confirmation email and two text messages leading up to the scheduled appointment. These reminders included a reminder about the mandatory use of face coverings. The consent form included an addendum describing the additional cleaning/sanitizing procedures taking place, as well as requirements for face coverings and social distancing. Each participant was required to state they had not interacted with someone who had been diagnosed with or exhibited symptoms of COVID-19, that they were not experiencing any symptoms of COVID-19, that they agreed to follow all safety procedures, and that they allowed their information to be recorded for potential contact-tracing purposes.

A total of 200 people participated in the experimental study: 66 in the control group, 66 in T1, and 68 in T2. Section 3 provides information on the demographic characteristics of participants. The overall eligibility rate (percentage of cases that completed the web-based or phone screening and met the eligibility criteria) was 42%. Among the 200 study participants, we recruited 73% using social media (Facebook and Twitter), 13% using

[6] The recruiting materials were available in Spanish to reach English-speaking Hispanics, but the study was conducted only in English.

Craigslist, and 14% using other recruiting efforts such as word of mouth. The no show rate not including cancellations was 17.5%.

2.3 Coding of Observation Data and Analysis

We used notational analysis to assess recorded actions and their frequencies during meal preparation. Notational analysis is a generic tool used to collect observed events and place them in an ordered sequence (Hughes & Franks, 1997); it has been used to track food safety behaviors because it enables the recording of specific details about events in the order in which they occur by associating a time stamp with actions (Clayton & Griffith, 2004). Notational analysis has been used in both nonparticipant and participant consumer food safety behavior observation studies, as well as participant foodservice observation (Chapman et al., 2010; Clayton & Griffith, 2004; Green et al., 2006; Redmond et al., 2004).

We developed coding rubrics (see Appendix G) to characterize the following behaviors:

- thermometer usage and other methods to determine doneness of bratwurst and hamburgers
- handwashing compliance according to CDC guidelines
- indirect cross-contamination (failure to properly clean and sanitize surfaces)
- storing of uncooked ground beef from a chub
- method used to wash the apple and carrot

A trained coder viewed each video and followed the rubric to indicate level of adherence to recommended behaviors while observing the participants. Coders were trained by reviewing the coding rubric and using practice food safety handling scenarios to compare inter- and intracoding reliability. Incorrect and inconsistent coding situations were discussed with coders to ensure that proper and consistent training occurred.

For each behavior of interest (identified by the use of bold text in the result tables shown in Section 3), we calculated proportions for the control group and each of the two treatment groups and conducted statistical testing using a chi-squared test for the differences between groups (control vs. T1, control vs. T2, and T1 vs. T2). We used a p value of $\leq .05$ to indicate statistical significance.

2.4 Microbiological Data and Analysis

As previously noted, a nonpathogenic strain of *E. coli* DH5-Alpha that fluoresces under UV light was used as the surrogate. We determined the concentration of DH5-Alpha on swab samples by enumerating the bacteria on selective media and visualizing colonies under UV light. To confirm effective decontamination of the kitchen between participants, one cleaning validation surface swab was taken before a participant began preparing the meal. We collected five additional surface samples and one lettuce sample from the prepared RTE

salad. Appendix D provides additional information on the microbiological analysis procedures.

For each surface and lettuce sample, we calculated prevalence and level of contamination by study group. For prevalence, we conducted statistical testing using a chi-squared test for the differences between groups (control vs. T1, control vs. T2, and T1 vs. T2). We used a p value of $\leq .05$ to indicate statistical significance.

2.5 Post-observation Interviews and Analysis

The post-observation interviews collected information on participants' behaviors while preparing the bratwurst, hamburgers, and RTE salad in the test kitchen and their usual behavior at home and other information. For the treatment groups, the interviewer probed for recall of the food safety instructions in the recipe and for T2 recall of the celebrity chef information (aided recall). If participants recalled the food safety information, they were asked if the information influenced their actions in the kitchen during the study and whether they believed the information would influence how they cook at home in the future. For T2, participants were also asked whether the celebrity chef's inclusion of food safety instructions influenced their behavior in the kitchen. Table 2-1 summarizes the information collected in the post-observation interviews (Appendix E provides the interview guide).

Table 2-1. Summary of Information Collected in the Post-observation Interviews

Self-reported Participant Behavior in the Test Kitchen and at Home	Response to Food Safety Instructions in Recipes
▪ Washing hands after handling bratwurst and ground beef during meal preparation	▪ Recalled food safety instructions in the recipes (unaided and aided recall)
▪ Preparation of bratwurst and hamburgers and food thermometer use	▪ Whether food safety instructions influenced actions during meal preparation (e.g., used thermometer, reinforced normal practices)
▪ Concerns about cross-contamination when handling raw meat products	▪ Whether food safety instructions will influence actions when cooking at home
▪ Experience with repackaging remaining ground beef in chubs	▪ Familiarity with celebrity chef who endorsed recipes for T2
▪ Cleaning/sanitizing practices	▪ Whether having the food safety instructions coming from a celebrity chef influenced how they prepared the meal
▪ Whether COVID-19 has played a role in how often or when wash hands	▪ Whether the celebrity chef who endorsed the T2 recipes or other celebrity chefs are trusted sources of food safety information

We audio-recorded the interviews and transcribed and coded the interview transcripts. Most of the questions were open ended, so to analyze the data, we coded the responses. We

used QSR International NVivo, Version 12 software to organize and code the data. We assigned a unique case number to each participant to link the screener data and post-observation data. We outputted the coded data to Excel and tabulated the responses by the three study groups.

3. Results

This section describes the characteristics of the study sample and presents the results of the meal preparation experiment for grilling bratwurst and hamburgers, handwashing compliance, cleaning and sanitizing, storing uncooked ground beef from a chub, and washing produce. We also present the results of the microbiological analysis that assessed cross-contamination during meal preparation.

3.1 Sample Characteristics

Of the 200 participants in the study sample, 75% were White and 90% were non-Hispanic. Participants represented a variety of ages with 28% in the 18 to 34 years old age category, 49% in the 35 to 54 years old age category, and 23% in the 55 years or older age category. About a third (34%) of participants had a 4-year college degree or more education, and 37% had at least one child living in the household (≤17 years). About 30% of participants had at least one individual in the household at risk for foodborne illness (i.e., adult aged 60 years or older; pregnant woman; child aged 5 years or younger; or individual diagnosed with diabetes, kidney disease, or another condition that weakens the immune system) (see Table 3-1). Table 3-2 compares the demographic characteristics of the study sample to the recruiting targets that were set for the study. The study generally met the recruiting targets.

The screening questionnaire collected information on participants' experience with purchasing and preparing bratwurst and hamburgers (Table 3-3). Many participants (87%) have experience buying fresh bratwurst and 74% had grilled bratwurst outdoor in the past 6 months. Seventy percent of participants reported purchasing chubs at least once in the past 3 months, with 42% reported purchasing chubs 1 to 3 times. The most common cited reasons for purchasing chubs were price (71%), convenience (42%), and size option (39%). Eighty-one percent of participants reported purposefully purchased meat or poultry in large quantities to repackage for cooking at a later date.

Table 3-1. Sample Characteristics

Characteristic	All Participants (*n* = 200)	Control: Standard Recipes (*n* = 66)	T1: Food Safety Recipes (*n* = 66)	T2: Food Safety Recipes+ Celebrity Endorsement (CE) (*n* = 68)
Gender				
Female	34% (67)	36% (24)	38% (25)	27% (18)
Male	65% (130)	61% (40)	62% (41)	72% (49)
Other/prefer not to answer	2% (3)	3% (2)	0% (0)	1% (1)
Race				
Caucasian or White	75% (151)	71% (47)	76% (50)	79% (54)
Black or African American	16% (32)	14% (9)	17% (11)	18% (12)
Other race[a]	9% (17)	15% (10)	8% (5)	3% (2)
Ethnicity				
Not Hispanic or Latino	90% (181)	89% (59)	92% (61)	90% (61)
Hispanic or Latino	10% (19)	11% (7)	8% (5)	10% (7)
Age				
18–34	28% (55)	24% (16)	29% (19)	29% (20)
35–54	49% (99)	46% (30)	56% (37)	47% (32)
55–64[b]	23% (46)	30% (20)	15% (10)	24% (16)
Education				
Less than high school, high school diploma/GED, or technical or vocational school	26% (52)	21% (14)	21% (14)	18% (12)
Some college	40% (80)	41% (27)	39% (26)	42% (29)
Bachelor's degree	19% (38)	20% (13)	20% (13)	25% (17)
Graduate or professional degree	15% (30)	18% (12)	20% (13)	15% (10)
Have child 17 or younger living in household	37% (74)	33% (22)	39% (26)	38% (26)
Have at-risk individual living in household[c]	30% (60)	20% (13)	29% (19)	41% (28)

[a] Other race includes American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and two or more races.

[b] People 65 years or older were excluded from the study because of increased COVID-19 risk.

[c] At-risk populations are people who are 60 years of age or older, children 5 years of age or younger, pregnant women, people diagnosed with diabetes or kidney disease, and people diagnosed with a condition that weakens the immune system.

Note: Responses may not sum to 100% because of rounding.

Source: 2020–2021 meal preparation experiment—screening questionnaire.

Table 3-2. Comparison of the Study Sample with Recruitment Targets

Characteristic	Study Sample (*n* = 200)	Recruitment Target (%)
Race		
White	75% (151)	75%
Non-White[a]	25% (49)	25%
Ethnicity		
Not Hispanic or Latino	90% (181)	90%
Hispanic or Latino	10% (19)	10%
Age		
18–34	28% (55)	25%
35–54	49% (99)	49%
55–64[b]	23% (46)	26%
Education		
Less than high school, high school diploma/GED, or technical or vocational school	26% (52)	26%
Some college	40% (80)	40%
Bachelor's degree	19% (38)	19%
Graduate or professional degree	15% (30)	15%
Household status		
Children (0–17)	37% (74)	35%
No children	63% (126)	65%

[a] Non-White includes Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, other races, or two or more races.

[b] People 65 years or older were excluded from the study because of increased COVID-19 risk.

Note: Responses may not sum to 100% because of rounding.

Source: 2020–2021 meal preparation experiment—screening questionnaire.

Table 3-3. Self-reported Participant Experience with Purchasing and Preparing Bratwurst and Hamburgers

Characteristic	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Bratwurst				
Participant has cooked raw/fresh bratwurst/sausages purchased at a meat counter	87% (174)	82% (54)	89% (59)	90% (61)
Participant has grilled product outdoors in the past 6 months	74% (148)	71% (47)	77% (51)	74% (50)
Hamburgers				
Frequency that participant purchased ground beef in a chub[a] within the past 3 months				
Never	30% (59)	30% (20)	29% (19)	29% (20)
1 to 3 times	42% (83)	44% (29)	42% (28)	38% (26)
4 to 6 times	17% (34)	14% (9)	14% (9)	24% (16)
7 to 12 times	8% (15)	5% (3)	14% (9)	4% (3)
More than 12 times	5% (9)	8% (5)	2% (1)	4% (3)
Reasons for purchasing chubs[b]				
Price	71% (100)	80% (37)	66% (31)	67% (32)
Convenience	42% (59)	35% (16)	43% (20)	48% (23)
Size option	39% (55)	41% (19)	36% (17)	40% (19)
Shelf life	17% (24)	20% (9)	11% (5)	21% (10)
Brand preference	11% (16)	13% (6)	11% (5)	10% (5)
Other	11% (16)	4% (2)	17% (8)	13% (6)
Participant has purposefully purchased meat or poultry in large quantities to repackage for cooking at later date	81% (161)	77% (51)	86% (57)	78% (53)
Number of participants	200	66	66	68

[a] Because participants may not be familiar with the word "chub," we asked the question as follows: "During the past 3 months, about how often did you purchase ground beef that is not sold in Styrofoam trays? This type of packaging is sometimes referred to as a chub. Chubs are a tube-like package that looks like a sausage with the ends sealed by metal crimps or clips."

[b] Only participants (n = 141) who reported purchasing chubs in the past 3 months answered this question. Participants could provide multiple responses, so the total may sum to more than 100%.

Note: Responses may not sum to 100% because of rounding. Participants who did not purchase the product were excluded from the calculations for prepare product and frequency of preparing the product.

Source: 2020–2021 meal preparation experiment—screening questionnaire.

3.2 Thermometer Use

The recipes for the two treatment groups instructed participants to "[g]rill burgers and brats until internal temperature reaches 160°F on food thermometer." Table 3-4 summarizes thermometer use for checking doneness of the bratwurst and hamburgers. There was a statistically significant difference between the percentage of control group participants who used a food thermometer to check the doneness of at least one bratwurst (55%) compared with T1 participants—recipe with food safety instructions (95%). Likewise, there was a statistically significant difference between the percentage of control group participants who used a food thermometer to check the doneness of at least one bratwurst (55%) compared with T2 participants—recipe with food safety instructions + celebrity endorsement (96%). The difference between the two treatment groups was not statistically significant. Among the five bratwurst cooked, the mean number of bratwurst checked for doneness averaged four for each group. The recommendation is to check the temperature of each item being cooked because of possible variations in temperatures.

Table 3-4. Observed Preparation of Bratwurst and Hamburgers

Behavior	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Bratwurst	*n* = 66	*n* = 66	*n* = 68
Participant used thermometer to check doneness[a]	**55% (36)[1,2]**	**95% (63)[1]**	**96% (65)[2]**
	SE = 0.06	SE = 0.03	SE = 0.03
Among participants who used thermometer, number of bratwurst checked	*n* = 36	*n* = 63	*n* = 65
All bratwurst (five)	72% (26)	75% (47)	65% (42)
Two to four	17% (6)	24% (15)	23% (15)
One	11% (4)	2% (1)	12% (8)
Mean number checked[b]	**4.22**	**4.46**	**4.05**
	SE = 0.23	SE = 0.12	SE = 0.18
Method used to determine doneness	*n* = 66	*n* = 66	*n* = 68
Only used thermometer	23% (15)	67% (44)	54% (37)
Only used touch (e.g., firmness)	21% (14)	2% (1)	0% (0)
Only used time	9% (6)	2% (1)	3% (2)
Only used visual cue (i.e., cut open to look inside)	6% (4)	2% (1)	0% (0)
Observed using more than one method, including thermometer	32% (21)	29% (9)	41% (28)
Observed using more than one method, *not* including thermometer	9% (6)	0% (0)	1% (1)

(continued)

Table 3-4. Observed Preparation of Bratwurst and Hamburgers (continued)

Behavior	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Hamburgers	*n* = 66	*n* = 66	*n* = 68
Participant used thermometer to check doneness[a]	**58% (38)[1,2]**	**95% (63)[1]**	**99% (67)[2]**
	SE = 0.06	SE = 0.03	SE = 0.01
Among participants who used thermometer, number of hamburgers checked	*n* = 38	*n* = 63	*n* = 67
One	8% (3)	0% (0)	6% (4)
Two	92% (35)	100% (63)	94% (63)
Mean number checked[b]	**1.9**	**2.0**	**1.9**
	SE = 0.04	SE = 0.00	SE = 0.03
Method used to determine doneness	*n* = 66	*n* = 66	*n* = 68
Only used thermometer	12% (8)	30% (20)	34% (23)
Only used touch (e.g., firmness)	21% (14)	3% (2)	0% (0)
Only used visual cue (i.e., cut open to look inside)	3% (2)	0% (0)	0% (0)
Only used time	0% (0)	0% (0)	0% (0)
Observed using more than one method, including thermometer	45% (30)	65% (43)	65% (44)
Observed using more than one method, *not* including thermometer	18% (12)	2% (1)	1% (1)

[a] We calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

[b] We calculated *p* value significance testing using repeated measures of analysis of variance (i.e., ANOVA) (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate means that are significantly different at $p \leq .05$.

Notes: Responses may not sum to 100% because of rounding. SE = standard error

Source: 2020–2021 meal preparation experiment—coding of food preparation.

Some participants, especially those in the control group, attempted to determine doneness of the bratwurst using indicators other than a thermometer. For the control group, 21% of participants relied solely on firmness (e.g., touch), 9% relied solely on time, and 6% relied solely on a visual cue (e.g., color). About one-third of participants (32%) used a thermometer *and* another indicator to determine doneness.

There was a statistically significant difference between the control group and each of the two treatment groups for the percentage of participants using a food thermometer to check the doneness of hamburgers; 58% of control group participants used a food thermometer

on at least one hamburger, while 95% of T1 and 99% of T2 used a food thermometer. The difference between the two treatment groups was not statistically significant. Nearly all participants in each of the three groups checked the doneness of both hamburgers.

Similarly to bratwurst, participants used other methods to determine doneness for the hamburgers. Twenty-one percent of control group participants relied solely on firmness (e.g., touch) and 3% relied solely on a visual cue (e.g., color); 45% of control group participants used more than one method *not* including a thermometer to determine doneness (see Table 3-4). Participants in the treatment groups rarely used other indicators to test for doneness.

According to the post-observation interviews (Table 3-5), 88% of all participants reported owning a food thermometer. About one-half of treatment group (T1 and T2) participants who reported owning a thermometer and using it in the test kitchen said they usually use one when grilling at home, whereas thermometer use in the test kitchen ranged from 95 to 99% for the two treatment groups, depending on the product.

Table 3-5. Self-Reported Thermometer Use

Question	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Self-reported food thermometer ownership	88% (176)	92% (61)	89% (59)	82% (56)
If own thermometer (*n* = 176), self-reported use of thermometer in test kitchen for bratwurst and/or hamburgers	88% (155)	70% (43)	97% (57)	98% (55)
If reported using thermometer (*n* = 155), do you usually use one to determine doneness when grilling at home?				
Yes	55% (85)	65% (28)	53% (30)	49% (27)
No	27% (42)	21% (9)	28% (16)	31% (17)
Depends on the food	18% (28)	14% (6)	19% (11)	20% (11)
Number of participants (unless otherwise noted)	200	66	66	68

Source: 2020–2021 meal preparation experiment—post-observation interview.

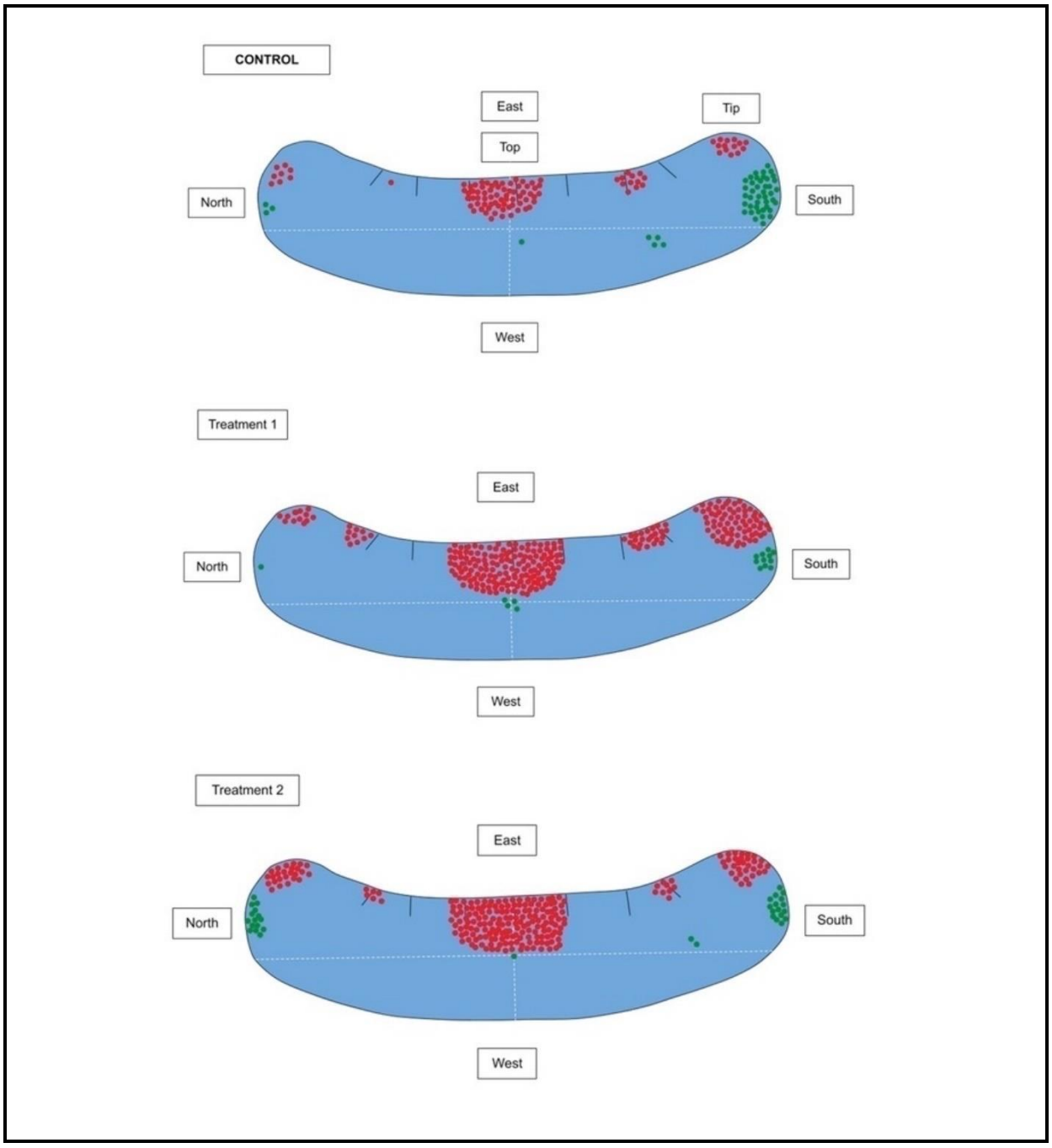
We attempted to code the final endpoint temperature by viewing the videos but were unable to ascertain the temperature for most participants (81%). Participants frequently stood in front of the camera or turned the thermometer away from them (and the camera) to read it, so few temperatures were visible. Because of the small number of participants, these

data are not shown. For the Year 5 study, we plan to purchase data-logging thermometers that will allow us to collect reliable data on final endpoint temperatures.

Figure 3-1 is a diagram of a bratwurst with a heat map indicating thermometer placement for the control and treatment group participants. The red-colored dots indicate points of thermometer insertion from the top, while green-colored dots indicate insertion from the ends of the bratwurst. Overall, participants inserted the thermometer into the top of the bratwurst most frequently (red dots), whereas the correct placement is into one of the ends of the bratwurst (green dots).

Figure 3-2 is a diagram of a hamburger with a heat map indicating thermometer placement for the control and treatment group participants. The red-colored dots indicate points of thermometer insertion from the top, while green-colored dots indicate insertion from the side. The majority of participants for all three groups inserted the thermometer into the top of the patty, whereas the correct placement is into the side of the patty (green dots).

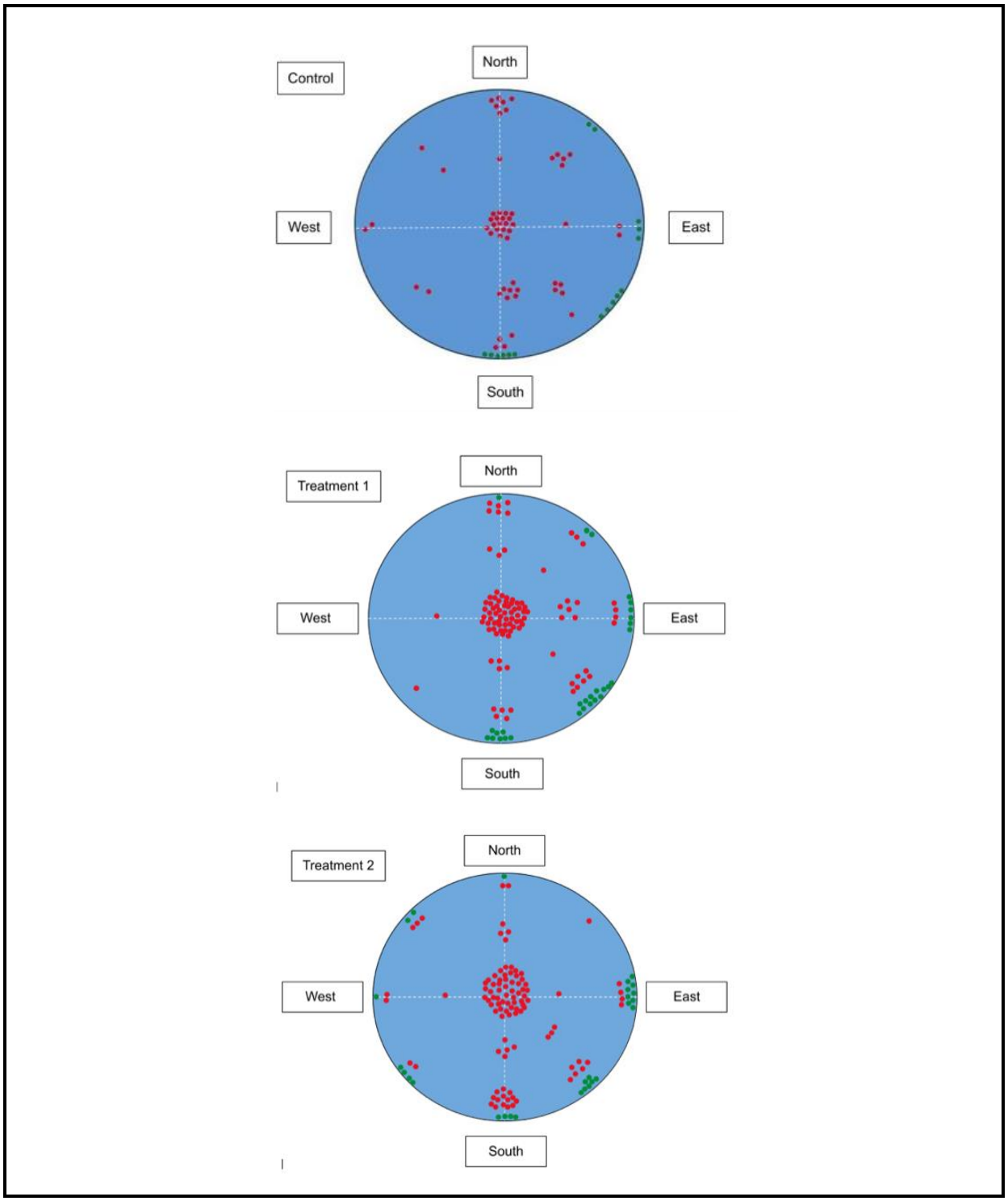
Figure 3-1. Bratwurst with Heat Maps Showing Thermometer Placement by Group



Note: Participants placed the bratwurst both vertically and horizontally on the grill. For bratwurst placed vertically, the tip pointing toward the top of the grill is labeled "North," and for bratwurst placed horizontally, the tip facing away from the stovetop is labeled "North." Red dots indicate thermometer insertion into the top of the bratwurst. Green indicates thermometer insertion into the end of the bratwurst. Heat maps reflect the first bratwurst that was checked for doneness. *n* = 36 (control), 63 (T1), 65 (T2)

Source: 2020–2021 meal preparation experiment—coding of food preparation.

Figure 3-2. Hamburger with Heat Maps Showing Thermometer Placement by Group



Note: "North" is the part of the grill that is farthest from the participant. Red dots indicate thermometer insertion into the top of the patty. Green indicates thermometer insertion into the side of the patty. Heat maps reflect the first hamburger that was checked for doneness. *n* = 38 (control), 63 (T1), 67 (T2)

Source: 2020–2021 meal preparation experiment—coding of food preparation.

Table 3-6 compares the results for Years 1 through 4 for thermometer use for control group participants (i.e., not exposed to an intervention). In Year 1, participants prepared turkey burgers with a garnish and a chef salad (Cates et al., 2018), in Year 2, participants who self-identified as poultry washers prepared chicken thighs and a mixed green salad, and in Year 3, participants prepared breaded not-ready-to-eat (NRTE) chicken cordon bleu from frozen (Cates et al., 2020). Thermometer use varied depending on the product cooked; the rate was highest for the NRTE chicken product and lowest for turkey burgers. The rate of thermometer use was significantly higher for hamburgers (58%) compared with turkey burgers (34%). Among thermometer users, checking the temperature of multiple items ranged from 76% for chicken thighs to 92% for hamburgers.

Table 3-6. Comparison of Thermometer Use for Annual Meal Preparation Experiments (Control Group Participants)

	Year 1 Turkey Burgers (*n* = 185)	Year 2 Chicken Thighs (*n* = 154)	Year 3 Frozen, Breaded NRTE Chicken (*n* = 196)	Year 4 Bratwurst (*n* = 66)	Year 4 Hamburgers (*n* = 66)
% used thermometer on at least one item	34%	44%	77%	55%	58%
% checked temperature of multiple items (among thermometer users)	79%	76%	85%	89%	92%

Note: NRTE = not ready to eat

Sources: 2017, 2018, 2019, and 2020-2021 meal preparation experiments—coding of food preparations.

3.3 Handwashing Compliance

The recipes for the two treatment groups instructed participants to "[w]ash hands with soap and water" both before beginning to prepare food and after handling raw ground beef. Inadequate handwashing has been identified as a contributing factor to foodborne illness, especially when preparing raw meat and poultry. Hands can become vectors that move pathogens around sites for foodborne pathogens found in raw meat and poultry and that contribute to home-acquired foodborne illnesses. The frequency and level of contamination of hands have not been well studied.

The total handwashing events required per observation were determined during the coding for each observation. A handwashing event was required for each of the following instances:

- before onset of food preparation
- anytime between touching the packaging for the bratwurst or hamburgers and then touching a different item

- after touching another person or self
- after touching a cell phone
- after multitasking (chores)
- after touching contaminated (post-meal) trash or a trash can

The total number of attempts per observation was the number of times a participant washed their hands. Each handwashing event was coded as successful or unsuccessful based on CDC's criteria: wet hands with water; rub hands with soap for at least 20 seconds; rinse hands with water; and dry hands using a clean, one-use towel. For example, participant 001T was required to wash her hands nine times but attempted only two times. Of these two times, neither was coded as successful because she did not rub her hands with soap for a total of 20 seconds. Our analysis only considered compliance with CDC's handwashing criteria; we did not consider risk reduction from participants following some but not all required steps of a successful handwashing event. It is estimated that proper handwashing results in approximately 1 log reduction (Montville, Chen, & Schaffner, 2002). Drying hands using a clean, one-use towel is an important step in handwashing because it can physically remove microbes and contaminants from hands, resulting in up to 1 additional log reduction (Huang, Ma, & Stack, 2012).

Table 3-7 summarizes handwashing compliance before meal preparation. The percentage of handwashing attempts was significantly higher among the two treatment groups (62% for T1 and 65% for T2) compared with the control group (44%). Among handwashing attempts, few contained all steps of a correct handwashing event according to CDC's criteria and were considered successful attempts: 3% for the control group, 5% for T1, and none for T2. The most common reason for unsuccessful handwashing was not rubbing hands with soap for at least 20 seconds (71% for the control group, 74% for T1, and 77% for T2), followed by not wetting hands with water (71% for the control group, 44% for T1, and 66% for T2).

Table 3-7. Observed Handwashing Compliance before Meal Preparation

	Control: Standard Recipes %	**T1: Food Safety Recipes %**	**T2: Food Safety Recipes+CE %**
Did not attempt	56% (37)	38% (25)	35% (24)
Attempts[a, b]	**44% (29)[1, 2]**	**62% (41)[1]**	**65% (44)[2]**
Successful attempts[c]	3% (1)	5% (2)	0% (0)
Unsuccessful attempts	97% (28)	95% (39)	100% (44)

(continued)

Table 3-7. Observed Handwashing Compliance before Meal Preparation (continued)

	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Reasons for unsuccessful attempt[d]			
Did not first wet hands with water	71% (20)	44% (17)	66% (29)
Did not use soap	0% (0)	0% (0)	2% (1)
Did not rub hands with soap for at least 20 seconds	71% (20)	74% (29)	77% (34)
Did not rinse hands with water	18% (5)	5% (2)	2% (1)
Did not dry hands	0% (0)	0% (0)	2% (1)
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	0% (0)	0% (0)	2% (1)
Number of participants	66	66	68

[a] We calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

[b] "Attempt" was defined as any time that a participant appeared to wash their hands; the attempt could be successful or unsuccessful.

[c] A successful attempt was defined as a participant meeting all CDC criteria for handwashing: wet hands with water; rub hands with soap for at least 20 seconds; rinse hands with water; and dry hands using a clean, one-use towel.

[d] There may be multiple reasons for unsuccessful attempts, so the total may sum to more than 100%.

Source: 2020–2021 meal preparation experiment-observed behavior.

Table 3-8 summarizes handwashing compliance during meal preparation. For each group, we observed between 496 (T2) and 570 (C) cases in which a handwashing event was required to prevent cross-contamination during meal preparation. Required handwashing events varied by person based on each participant's handling behaviors; as a result, some participants had a greater number of required handwashing events than others (e.g., touched the packaging of the ground beef chub more often).

Table 3-8. Observed Handwashing Compliance during Meal Preparation

	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Handwashing event required	570	496	498
Did not attempt	75% (430)	71% (353)	70% (349)
Attempts[a, b]	**25% (140)**	**29% (143)**	**30% (149)**
Successful attempts[c]	3% (4)	6% (9)	7% (11)
Unsuccessful attempts	97% (136)	94% (134)	93% (138)
Reasons for unsuccessful attempt[d]			
Did not wet hands with water	46% (63)	35% (46)	36% (49)
Did not use soap	15% (20)	14% (18)	13% (18)
Did not rub hands with soap for at least 20 seconds	85% (116)	80% (106)	88% (122)
Did not rinse hands with water	39% (53)	23% (31)	13% (18)
Did not dry hands	19% (26)	23% (31)	20% (27)
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	24% (32)	27% (35)	32% (44)
Number of participants	66	66	68

[a] We calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

[b] "Attempt" was defined as any time that a participant appeared to wash their hands; the attempt could be successful or unsuccessful.

[c] A successful attempt was defined as a participant meeting all CDC criteria for handwashing: wet hands with water; rub hands with soap for at least 20 seconds; rinse hands with water; and dry hands using a clean, one-use towel.

[d] There may be multiple reasons for unsuccessful attempts, so the total may sum to more than 100%.

Source: 2020–2021 meal preparation experiment—observed behavior.

The percentage of handwashing attempts was 25% for the control group, 29% for T1, and 30% for T2. Among handwashing attempts, few contained all steps of a correct handwashing event according to CDC's criteria and were considered successful attempts: 3% for the control group, 6% for T1, and 7% for T2. There were no statistically significant differences in handwashing rates between the three groups. The most common reason for unsuccessful handwashing was not rubbing hands with soap for at least 20 seconds (85% in the control group, 80% in T1, and 88% in T2), followed by not wetting hands with water as a first step (46% in the control group, 35% in T1, and 36% in T2).

Participants were asked about their handwashing behavior during the post-observation interview (see Table 3-9). Nearly all participants (96%) said that washing hands before

cooking was something they typically do at home, whereas the observed rate for attempting handwashing was much lower (ranging from 44 to 65% depending on the group). When cooking at home and touching food, nearly half of participants (48%) said they wash their hands after handling raw meat or poultry, 27% said it varies with the type of food, and 13% said they do so between handling each item. The observed rate for attempting handwashing for required events ranged from 25 to 30% depending on the group.

For Year 4, we asked about the role that the COVID-19 pandemic and associated handwashing guidance from CDC may have played in changing participants' handwashing behaviors. Forty percent of participants said government recommendations influence their decision to wash their hands to some extent. These participants described the recommendations as "common sense" or viewed these recommendations as public health measures. Some participants noted that their food service background also influenced their handwashing. About 78% of participants said that COVID-19 played a role in increasing the frequency of handwashing; however, participants said this increase in handwashing is not specific to meal preparation times but also included returning home from work or shopping.

Table 3-9. Self-reported Handwashing Behaviors

Question	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Did you wash your hands before cooking today (in the test kitchen)?				
Yes	96% (193)	92% (61)	98% (65)	99% (67)
No	4% (7)	8% (5)	2% (1)	1% (1)
If washed hands (*n* = 193), is this something you usually do when cooking at home?				
Yes	95% (184)	96% (59)	97% (63)	93% (62)
No	1% (2)	2% (1)	0% (0)	1% (1)
Sometimes	4% (7)	2% (1)	3% (2)	6% (4)
When cooking at home and you touch food, when do you wash your hands?[a]				
After handling raw meat or poultry	48% (96)	45% (30)	48% (32)	50% (34)
Varies by type of food	27% (54)	21% (14)	32% (21)	28% (19)
Between handling each item	13% (25)	14% (9)	12% (8)	12% (8)
Answer unclear	8% (16)	11% (7)	6% (4)	7% (5)
Before cooking	4% (7)	8% (5)	2% (1)	1% (1)
At the end of meal preparation	1% (2)	2% (1)	0% (0)	1% (1)

(continued)

Table 3-9. Self-reported Handwashing Behaviors (continued)

Question	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Do government recommendations influence your decision to wash your hands?				
No	60% (119)	62% (41)	56% (37)	60% (41)
Some	40% (81)	38% (25)	44% (29)	40% (27)
Has COVID-19 played a role in how often or when you wash your hands?				
Yes	78% (156)	68% (45)	86% (57)	79% (54)
No	22% (44)	32% (21)	14% (9)	21% (14)
Number of participants (unless otherwise noted)	200	66	66	68

[a] Participants could provide multiple responses, so the total may sum to more than 100%.
Note: Responses may not sum to 100% because of rounding.
Source: 2020–2021 meal preparation experiment—post-observation interview.

Table 3-10 compares the results for Years 1 through 4 for handwashing compliance among control group participants, which varied by study year. The handwashing rate for before meal preparation, which should not be influenced by the type of food prepared, was significantly lower for Year 4 (44%) compared with Year 2 (74%) and Year 3 (71%). We speculate that the lower handwashing rate for Year 4 may be due to participants using hand sanitizer upon arrival as a COVID-19 precaution. Two hand sanitizer stations, which were not provided in previous years of the study, were available to participants before they entered the kitchen. Social distancing measures may also have influenced handwashing rates. In previous years of the study, researchers were able to walk the participant around the kitchen during the introduction and clearly show the participant the location of utensils and dishes in drawers and cabinets. Because of mandatory social distancing, the introduction and orientation were limited. The lower handwashing rates might reflect participants opening cabinets and drawers to become familiar with the kitchen when starting meal preparation (these participants would have been coded as not washing their hands before starting meal preparation even if they then washed their hands before touching any food). Because we did not ask participants during the post-observation interviews why they did not wash their hands before meal preparation, we do not know the reason with certainty. We will ask follow-up questions about reasons for not washing hands before meal preparation and record the first surface touched at the start of meal preparation in the forthcoming Year 5 study. Other reasons for differences in handwashing rates by study year are also possible, such as differences in the characteristics of the study sample. The study sample for Year 4 was limited to people who cook on an outdoor grill and had a larger

percentage of males relative to Years 2 and 3. Additional analysis is needed to understand why the rate of handwashing before meal preparation varied by study year.

For handwashing during meal preparation, the rates for attempting handwashing were 26% for Year 2, 3% for Year 3, and 25% for Year 4. The results suggest that handwashing rates varied by product; the rates for chicken thighs and bratwurst/hamburgers were similar (about 25%), whereas the rate for frozen, breaded NRTE chicken was much lower (3%). Consistent with prior years, most Year 4 participants attempting handwashing before and during meal preparation did so unsuccessfully, and the most common reason for failure was not rubbing hands with soap for 20 seconds.

Table 3-10. Comparison of Handwashing Compliance for Annual Meal Preparation Experiments (Control Group Participants)

	Year 1 Turkey Burgers	Year 2 Chicken Thighs	Year 3 Frozen, Breaded NRTE Chicken	Year 4 Bratwurst and Hamburgers
Handwashing event required before the start of or during meal preparation[a]	1,195	—	—	—
% did not attempt	69%	—	—	—
% attempt	31%	—	—	—
% successful attempt (out of all attempts)	3%	—	—	—
Handwashing before the start of meal preparation	—	154	196	66
% did not attempt	—	26%	29%	56%
% attempt[b]	**—**	**74%[1]**	**71%[2]**	**44%[1,2]**
% successful attempt (out of all attempts)	—	1%	4%	3%
Handwashing event required during meal preparation	—	1,145	499	570
% did not attempt	—	74%	97%	75%
% attempt	—	26%	3%	25%
% successful attempt (out of all attempts)	—	1%	0%	3%

[a] For Year 1, data were not available by when handwashing took place (i.e., before the start of or during meal preparation), so the combined data are presented.

[b] We calculated *p* value significance testing using a chi-squared test for the difference between years. Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

Sources: 2017, 2018, 2019, and 2020–2021 meal preparation experiment—coding of food preparations.

3.4 Cleaning and Sanitizing

The recipes for the two treatment groups instructed participants to "[c]lean and then sanitize the counter and utensils after touching uncooked ground beef." Cleaning and then sanitizing kitchen surfaces and equipment can help prevent cross-contamination. Cleaning is defined by CDC as washing a surface with soap and warm water to remove dirt and debris. Sanitizing reduces the number of bacteria present on a surface by using a specific sanitizing compound such as a solution of chlorine bleach, quaternary ammonia, or an alcohol-based solution to spray the surface with a specified contact time and either letting it dry or wiping it dry with a clean, one-use towel so that bacterial loads, including pathogens, can be reduced.

Tables 3-11 provides information on the surface where the chub was placed during preparation, the number of attempts, successful attempts (cleaning and then sanitizing), and unsuccessful attempts (e.g., cleaning only or sanitizing only) by study group specific to the surface where the chub was placed during preparation. Results are shown for two events: immediately following handling of the chub and the end of the observation. Most participants placed the chub on a cutting board or plate to prepare the hamburgers or dumped the ground beef into a bowl without letting the ground beef or chub packaging touch a surface. Some participants (15 to 20% depending on the study group) prepared the chub directly on the counter, which is not recommended.

Immediately after handling the chub, 31% of control group participants, 53% of T1 participants, and 46% of T2 participants attempted cleaning and sanitizing; the higher rate of attempts for T1 compared with the control group was statistically significant. The rate of successful attempts (cleaned and then sanitized) ranged from 42 to 53%. Most of the unsuccessful events were due to a failure to sanitize.

At the end of meal preparation, 63% of control group participants, 36% of T1 participants, and 43% of T2 participants attempted cleaning and sanitizing; the lower rate of attempts for T1 compared with the control group was statistically significant (among participants who had not previously cleaned/sanitized the surface). The rate of successful attempts (cleaned and then sanitized) ranged from 67 to 75%. Most of the unsuccessful events were due to a failure to sanitize.

Table 3-11. Observed Cleaning and Sanitizing during Chub Preparation

	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Surface where chub was placed			
Cutting board	65% (43)	68% (45)	76% (52)
Counter	20% (13)	17% (11)	15% (10)
Other[a]	12% (8)	14% (9)	9% (6)
Plate	3% (2)	1% (1)	0% (0)
Event—Immediately following handling chub			
Attempt[b, c]	**31% (20)[1]**	**53% (31)[1]**	**46% (30)**
Successful attempts[d] (cleaned and then sanitized)	50% (10)	42% (13)	53% (16)
Unsuccessful attempts	50% (10)	58% (18)	47% (14)
Water only[e]	0% (0)	11% (2)	7% (1)
Clean only[f]	90% (9)	72% (13)	71% (10)
Sanitize only[g]	10% (1)	17% (3)	21% (3)
Did not attempt	69% (44)	47% (27)	54% (35)
Not applicable[h] (excluded from analysis)	3% (2)	12% (8)	4% (3)
Event—End of observation			
Attempt[b, c]	**63% (27)[1]**	**36% (21)[1]**	**43% (28)**
Successful attempt[d] (cleaned and then sanitized)	74% (20)	67% (14)	75% (21)
Unsuccessful attempts	26% (7)	33% (7)	25% (7)
Water only[e]	14% (1)	0% (0)	29% (2)
Clean only[f]	71% (5)	100% (7)	71% (5)
Sanitize only[g]	14% (1)	0% (0)	0% (0)
Did not attempt	37% (16)	64% (37)	57% (37)
Not applicable[h] or cleaned and/or sanitized immediately after handling chub (excluded from analysis)	35% (23)	12% (8)	4% (3)
Number of participants	66	66	68

[a] "Other" refers to instances where the participant opened the package midair with scissors and then dumped the meat into a bowl and immediately threw the packaging away.

[b] We calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

[c] "Attempt" was defined as any time that a participant appeared to clean the surface; the attempt could be successful or unsuccessful.

[d] "Successful" refers to cleaning the surface, followed by sanitizing.

Table 3-11. Observed Cleaning and Sanitizing during Chub Preparation (continued)

[e] "Water only" refers to if the participant only used water to rinse the surface and did not use soap, detergent, or any of the provided sanitizers.

[f] "Clean only" refers to the use of only soap or detergent to clean.

[g] "Sanitize only" refers to the use of one of the provided sanitizers (containing chlorine bleach, quaternary ammonia, or alcohol-based) to spray the surface and wiped it dry with a clean, one-use towel.

[h] Some participants opened the packaging on tin foil, plastic wrap, or paper towels laid on the counter and then discarded these items, so these are considered N/A cleaning attempts and were excluded from the analysis.

Source: 2020–2021 meal preparation experiment—observed behavior

Participants were asked about their cleaning and sanitizing practices in the post-observation interview (see Table 3-12). Ninety-six percent of participants believed that raw bratwurst could spread germs to other food in the kitchen. When asked what else might spread germs for the meal prepared in the test kitchen, 35% mentioned produce, 32% mentioned utensils or other surfaces, and 12% mentioned hamburger.[7] Overall, 68% of participants said that they use chlorine bleach or sanitizer when cleaning up after preparing bratwurst at home, while 18% clean with soap, and 8% wash their hands.

Table 3-12. Self-reported Behaviors for Cleaning and Sanitizing When Preparing Bratwurst and Hamburgers at Home

Question	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Can raw bratwurst spread germs to other food in your kitchen?				
Yes	96% (192)	97% (64)	94% (62)	97% (66)
No	3% (5)	2% (1)	5% (3)	1% (1)
Answer unclear	2% (3)	2% (1)	2% (1)	1% (1)
For the meal you prepared today, what else might spread germs?[a]				
Produce	35% (69)	35% (23)	36% (24)	32% (22)
Utensils or other surfaces	32% (63)	33% (22)	32% (21)	29% (20)
Hamburger	12% (24)	14% (9)	9% (6)	13% (9)
Hands	3% (5)	3% (2)	5% (3)	0% (0)
Things in the air	1% (1)	2% (1)	0% (0)	0% (0)
Grill	1% (1)	2% (1)	0% (0)	0% (0)

(continued)

[7] We did not ask a follow-up question on whether participants believed that raw hamburger could spread germs.

Table 3-12. Self-reported Behaviors for Cleaning and Sanitizing When Preparing Bratwurst and Hamburgers at Home (continued)

Question	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Pets	1% (1)	0% (0)	2% (1)	0% (0)
Nothing else	2% (3)	3% (2)	2% (1)	0% (0)
Other	14% (27)	5% (3)	12% (8)	24% (16)
Answer unclear	3% (6)	5% (3)	3% (2)	1% (1)
When preparing bratwurst at home, how do you clean up after you are finished?				
Use chlorine bleach or another sanitizer	68% (136)	71% (47)	70% (46)	63% (43)
Clean with soap/wipe down surfaces	18% (35)	20% (13)	20% (13)	13% (9)
Wash hands	8% (16)	8% (5)	8% (5)	9% (6)
Use only water	1% (1)	0% (0)	0% (0)	1% (1)
Throw away packaging	1% (1)	0% (0)	0% (0)	1% (1)
Answer unclear	6% (11)	2% (1)	3% (2)	12% (8)
If you purchased a large quantity of ground beef with the plan to use part of it for a meal and to store the rest, when would you store ground beef not used for the meal?				
Just before meal preparation	45% (90)	45% (30)	39% (26)	50% (34)
During meal preparation	23% (46)	26% (17)	27% (18)	16% (11)
When coming home from store	20% (40)	21% (14)	18% (12)	21% (14)
End of meal preparation	9% (18)	5% (3)	12% (8)	10% (7)
Did not specify when	2% (4)	2% (1)	3% (2)	1% (1)
Not asked	1% (2)	2% (1)	0% (0)	1% (1)
Number of participants	200	66	66	68

[a] Participants could provide multiple responses, so the total may sum to more than 100%.

Note: Responses may not sum to 100% because of rounding.

Source: 2020–2021 meal preparation experiment—post-observation interview.

When purchasing large quantities of group beef, 45% of participants would store the meat they do not plan to cook just before meal preparation, 23% would store it during meal preparation, and 20% would store it after coming home from the store. Few (9%) would wait until the end of meal preparation.

Participants were observed when repackaging the unused ground beef from the chub (see Table 3-13). Most participants (91 to 95%) placed the remaining ground beef in the

refrigerator instead of the freezer. One participant left the ground beef on the counter. Few participants (11 to 16%) labeled the package. Among participants who labeled the package, all wrote the date on the label, and most (71 to 80%) provided a description.

Table 3-13. Observed Repackaging of Unused Ground Beef

Question	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Location of stored beef			
Refrigerator	95% (61)	92% (56)	91% (60)
Freezer	5% (3)	8% (5)	8% (5)
Left on counter	--	--	1% (1)
Labeled the package			
Yes	16% (10)	11% (7)	12% (8)
No	84% (54)	89% (54)	88% (58)
If yes, information provided on label			
Date	100% (10)	100% (7)	100% (8)
Description	80% (8)	71% (5)	75% (6)
Number of participants	64	61	66

Note: Data were not available for nine participants because pictures failed to upload.

Source: 2020–2021 meal preparation experiment—pictures taken after completion of meal preparation.

Participants were also asked about how they would typically prepare, handle, and store bratwurst and hamburgers when cooking at home (Table 3-14). As previously noted, we instructed participants to prepare the bratwurst and hamburgers before the salad. Overall, 66% of participants said they would prepare bratwurst and hamburgers before preparing the salad when cooking at home whereas preparing the salad first would help to reduce the risk of cross-contamination. Participants said they would place the raw meat on a plate (31%), bowl (28%), or cutting board (11%) before putting it on the grill. Most participants said they would put any ground beef that they did not cook in a plastic/freezer bag (75%). About two-thirds of participants (64%) said they would label the package, whereas few participants did so in the test kitchen (11 to 16%).

Table 3-14. Self-reported Behaviors for Preparing, Handling, and Storage When Preparing Bratwurst and Hamburgers at Home

Question	All Participants %	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Which food would you typically prepare first at home?				
Bratwurst/hamburgers	66% (131)	71% (47)	53% (35)	72% (49)
Salad	34% (67)	27% (18)	47% (31)	26% (18)
Depends on the situation	1% (2)	2% (1)	0% (0)	1% (1)
What would you place the raw meat on before putting on the grill?				
Plate	31% (61)	29% (19)	32% (21)	31% (21)
Bowl	28% (56)	30% (20)	24% (16)	29% (20)
Cutting board	11% (21)	9% (6)	11% (7)	12% (8)
Wax/parchment paper	6% (11)	5% (3)	6% (4)	6% (4)
Baking sheet/tray	6% (12)	6% (4)	8% (5)	4% (3)
Did not explain step by step	4% (7)	9% (6)	2% (1)	0% (0)
Other	16% (32)	12% (8)	18% (12)	18% (12)
What would you put the unused ground beef in?				
Plastic/freezer bag	75% (150)	76% (50)	73% (48)	76% (52)
Wrap plastic over the chub package	13% (26)	11% (7)	14% (9)	15% (10)
Plastic container	6% (12)	6% (4)	9% (6)	3% (2)
Aluminum foil	1% (1)	2% (1)	0% (0)	0% (0)
Other	5% (10)	5% (3)	5% (3)	6% (4)
Answer unclear	1% (1)	2% (1)	0% (0)	0% (0)
Would you label the ground beef?				
Yes	64% (127)	71% (47)	58% (38)	62% (42)
No	36% (71)	27% (18)	42% (28)	37% (25)
Answer unclear	1% (2)	2% (1)	0% (0)	1% (1)
Number of participants	200	66	66	68

Note: Responses may not sum to 100% because of rounding.

Source: 2020–2021 meal preparation experiment—post-observation interview.

3.5 Produce Washing

Table 3-15 summarizes participants' behaviors for produce washing (one carrot and one apple) when preparing the RTE salad. The FDA recommends that consumers wash produce such as carrots and apples by rubbing them under cold running water; this instruction was included in the recipes for T1 and T2. Rates of properly washing the carrot for the RTE salad were slightly higher in the treatment groups (84% for T1 and 75% for T2) than the control group (71%); however, the differences were not statistically significant. Similarly, rates of properly washing the apple for the RTE salad were slightly higher in the treatment groups (83% for T1 and 79% for T2) than the control group (74%); however, the differences were not statistically significant. For both the carrot and apple, about 40% of control group participants did not attempt washing, whereas nearly all T1 and T2 participants attempted washing, although some failed to rub the product with their hands so the attempt was unsuccessful.

The FDA recommends that consumers not wash or rinse commercially bagged lettuce to avoid cross-contamination. Compared with the control group (80%), the percentage of participants not washing the bagged lettuce was higher among the two treatment groups (89% for T1 and 87% for T2); however, the differences were not statistically significant.

Table 3-15. Observed Salad Preparation: Produce Washing

	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Carrots			
Attempts	62% (41)	95% (63)	94% (64)
Successful attempt—rubbed with hands under running water[a]	**71% (29)**	**84% (53)**	**75% (48)**
Unsuccessful attempt[b]	29% (12)	16% (10)	25% (16)
Did not attempt	38% (25)	5% (3)	6% (4)
Apples			
Attempts[c]	59% (39)	97% (64)	100% (68)
Successful attempt– rubbed with hands under running water[a]	**74% (29)**	**83% (53)**	**79% (54)**
Unsuccessful attempt[b]	26% (10)	17% (11)	19% (13)
Did not attempt	41% (27)	3% (2)	0% (0)

(continued)

Table 3-15. Observed Salad Preparation: Produce Washing (continued)

	Control: Standard Recipes %	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Bagged lettuce			
Washed or rinsed	20% (13)	11% (7)	13% (9)
Did not wash[a]	**80% (53)**	**89% (59)**	**87% (59)**
Number of participants (unless otherwise noted)	66	66	68

[a] We calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

[b] Unsuccessful attempts including rinsing with water without rubbing and soaking in water.

[c] One T2 participant scrubbed the apple with their hands and also soaked it. This participant was excluded, so successful and unsuccessful attempts sum to 67 rather than 68.

Source: 2020–2021 meal preparation experiment—observed behavior

3.6 Cross-Contamination and Microbiological Analysis

To assess the extent of cross-contamination during meal preparation, we examined the spread of *E. coli* DH5-Alpha from the ground beef packaged in chubs to various surfaces in the kitchen and the prepared RTE salad. Lack of or failed handwashing attempts and failure to properly clean and sanitize surfaces that come into contact with raw meat can spread pathogens to high-touch surfaces through contact of contaminated hands to surfaces and foods.

We used the microbiological data to identify both the direct and indirect cross-contamination events that occurred during the meal preparation experiment. Direct cross-contamination is defined as when raw meat or raw meat packaging (in this case ground beef) comes into direct contact with an RTE food or a food handling surface or utensil and the area is not cleaned and sanitized after contact. Indirect cross-contamination is when utensils, surfaces, or hands make contact with a contaminant and then are not cleaned or sanitized adequately before the next use; any time between touching raw meat or packaging and then touching a nonmeat item; touching a mobile device; or touching trash. We analyzed the data for the counter area where the chub was opened, the sink basin, spice containers, cupboard handles, the plate or cutting board if it was handwashed, and the lettuce from the prepared RTE salad. Table 3-16 shows the prevalence and level of contamination for these sites, as well as the prevalence and level of contamination on the salad lettuce.

Across all participants, the surface most often contaminated was the sink basin (28% of participants). The rate of contamination for the spice containers was 12%. Rates of contamination were relatively low for the cupboard handle (8%) and the counter area where

Table 3-16. Prevalence of Surrogate Contamination and Level of Contamination for Locations in the Kitchen

Location		All Participants	Control: Standard Recipes	T1: Food Safety Recipes	T2: Food Safety Recipes+CE
Salad lettuce	**Prevalence contaminated % (*n*)[a]**	**17.09% (*198*)**	**13.64% (*66*)**	**20.31% (*64*)**	**17.65% (*68*)**
	Level of contamination ± SD, log CFU/25 g (*n*)	1.69 ± 0.81 (*34*)	1.51 ± 0.52 (*9*)	1.73 ± 0.97 (*13*)	1.78 ± 0.83 (*12*)
Counter area where chub was opened	**Prevalence contaminated % (*n*)[a]**	**2.51% (*199*)**	**4.55% (*66*)**	**0.00% (*65*)**	**2.94% (*68*)**
	Level of contamination ± SD, log CFU/100 cm^2 (*n*)	2.30 ± 0.65 (*5*)	1.87 ± 0.33 (*3*)	0.00 ± 0.00 (*0*)	2.94 ± 0.37 (*2*)
Sink basin	**Prevalence contaminated % (*n*)[a]**	**28.28% (*198*)**	**32.31%[1] (*65*)**	**16.92%[1,2] (*65*)**	**35.29%[2] (*68*)**
	Level of contamination ± SD, log CFU/100 cm^2 (*n*)	1.88 ± 0.85 (*56*)	1.63 ± 0.72 (*21*)	2.10 ± 1.12 (*11*)	1.99 ± 0.79 (*24*)
Spice containers	**Prevalence contaminated % (*n*)[a]**	**12.06% (*199*)**	**16.67% (*66*)**	**10.77% (*65*)**	**8.82% (*68*)**
	Level of contamination ± SD, log CFU/100 cm^2 (*n*)	1.78 ± 0.83 (*24*)	1.62 ± 0.90 (*11*)	1.59 ± 0.44 (*7*)	2.30 ± 0.96 (*6*)
Cupboard handle	**Prevalence contaminated % (*n*)[a]**	**8.04% (*199*)**	**12.12% (*66*)**	**4.62% (*65*)**	**7.35% (*68*)**
	Level of contamination ± SD, log CFU/100 cm^2 (*n*)	1.52 ± 0.66 (*16*)	1.61 ± 0.79 (*8*)	1.57 ± 0.52 (*3*)	1.34 ± 0.60 (*5*)
Plate or cutting board if hand washed	**Prevalence contaminated % (*n*)[a]**	**32.08% (*53*)**	**45.45% (*11*)**	**36.84% (*19*)**	**21.74% (*23*)**
	Level of contamination ± SD, log CFU/100 cm^2 (*n*)[b]	2.33 ± 1.08[b] (*16*)[c]	2.36 ± 1.09[b] (*4*)[c]	2.08 ± 1.07 (*7*)	2.66 ± 1.23 (*5*)
Number of samples		199	66	65	68

[a] We calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. T1, control vs. T2, and T1 vs. T2). Pairs of superscripted numbers indicate proportions that are significantly different at $p \leq .05$.

[b] Mean and SD do not include one control group sample determined to be an outlier because it was too high to count (>6.5 log CFU/100 cm^2).

[c] Total count of positive samples includes one sample found to have >6.5 log CFU/100 cm^2 (determined to be an outlier).

Notes: A positive result was any colony that fluoresced under ultraviolet light when grown on selective media. One observation was not included due to detecting surrogate in the cleaning validation sample. (*n*) = number of samples used in the analysis; SD = standard deviation

Source: 2020–2021 meal preparation experiment—microbiological samples.

the chub was opened (3%). Among participants handwashing the plate or cutting board used to prepare the hamburgers from the chub, 32% of participants did not thoroughly wash the plate/cutting board (i.e., it was contaminated with the surrogate). Across all participants, the prevalence for contamination of the salad lettuce was 17%.

We examined whether differences in the prevalence rates for contamination were statistically significant (control vs T1, control vs T2, and T1 vs T2). For the sink basin, the prevalence rate was higher for the control group (32%) compared with T1 (17%); the prevalence rates for T1 (17%) and T2 (35%) were also significantly different. No other differences were observed.

3.7 Participants' Response to Intervention (Treatment Groups Only)

During the post-observation interviews, we collected information about the treatment group participants' responses to the food safety instructions included in the recipes (see Table 3-17). As previously noted, the questions asked were generally open ended, and the responses were coded into the categories shown in the table. Many participants in the two treatment groups reported typically cooking from a recipe (70% for T1 and 63% for T2). Most participants reported that they noticed the food safety instructions in the recipes (92% for T1 and 90% for T2). About 52% of T1 and 36% of T2 participants had previously noticed food safety instructions. The sources most commonly cited were recipes and food packaging.

Table 3-17. Treatment Group Participants' Response to Intervention

Question	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Do you usually cook from a recipe?		
Yes	70% (46)	63% (43)
No	30% (20)	37% (25)
Did you notice food safety instructions in the recipes today?		
Yes	92% (61)	90% (61)
No	8% (5)	10% (7)

(continued)

Table 3-17. Treatment Group Participants' Response to Intervention (continued)

Question	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Have you ever noticed instructions like these before?		
Yes	52% (32)	36% (22)
No	48% (29)	64% (39)
If yes, where? (*n* = 32 for T1 and *n* = 22 for T2)		
Recipes	38% (12)	45% (10)
Food packaging	25% (8)	27% (6)
Cooking shows/cooking magazines	6% (2)	0% (0)
Other	3% (1)	5% (1)
Did not specify	28% (9)	23% (5)
If recalled food safety instructions, did the instructions influence how you prepared the meal today? (*n* = 61 for T1 and *n* = 61 for T2)		
Yes, influenced actions	74% (45)	75% (46)
Followed the recipe closely	27% (12)	7% (3)
Used thermometer	22% (10)	24% (11)
Reinforced usual practices	11% (5)	33% (15)
Provided general awareness	7% (3)	7% (3)
Washed hands and cleaned up	7% (3)	13% (6)
Washed produce	4% (2)	2% (1)
Concerned about what meat touched	0% (0)	2% (1)
Reason not stated or unclear	22% (10)	13% (6)
No, did not influence actions	26% (16)	25% (15)
Reinforced usual practices	75% (12)	80% (12)
Reason not stated or unclear	25% (4)	20% (3)
If recalled, do you think the information will influence your food preparation in the future? (*n* = 61 for T1 and *n* = 61 for T2)		
Yes, will influence	64% (39)	66% (40)
Will use new food safety measures	44% (17)	35% (14)
Will reinforce usual practices	31% (12)	38% (15)
Will seek out new recipes	13% (5)	15% (6)
Answer unclear	13% (5)	13% (5)
No, will not influence	36% (22)	31% (19)
Will reinforce usual practices	23% (5)	26% (5)
Other	59% (13)	63% (12)
Answer unclear	0% (0)	3% (2)

(continued)

Table 3-17. Treatment Group Participants' Response to Intervention (continued)

Question	T1: Food Safety Recipes %	T2: Food Safety Recipes+CE %
Are there additional food safety instructions you would add to the recipes?		
Yes	38% (23)	33% (20)
Information about cross-contamination	35% (8)	35% (7)
Information about proper storage	17% (4)	15% (3)
Information about washing produce	17% (4)	20% (4)
Wash hands, clean up more often	9% (2)	10% (2)
Other (e.g., time/temperature relationship, water temperature)	13% (3)	20% (4)
General tips (not related to food safety)	9% (2)	0% (0)
No	57% (35)	67% (41)
Answer unclear/question not asked	5% (3)	0% (0)

Note: Responses may not sum to 100% because of rounding.

Source: 2020–2021 meal preparation experiment—post-observation interview.

Among the participants who recalled the food safety instructions, about three-fourths of participants said the information influenced their actions during meal preparation (74% for T1 and 75% for T2). When asked how the inclusion of the food safety instructions influenced their behavior, these participants most often mentioned that they followed the recipe more closely, referenced their thermometer, or mentioned that it reinforced their usual practices. Among the one-fourth of participants who said the food safety instructions did not influence their actions during meal preparation, most mentioned that it reinforced their usual practices.

Among the participants who recalled the food safety instructions, about two-thirds of participants said the information would influence their actions in the future (64% for T1 and 66% for T2). When asked whether they would suggest adding other food safety instructions to the recipes, about one-third said yes, and suggested adding more information about cross-contamination, produce washing, and proper storage.

Participants in the T2 group were asked additional questions about Kenji Lopez-Alt, the celebrity chef featured in the recipes provided to T2 participants, and celebrity chefs in general (see Table 3-18). Most participants (81%) had not heard of him prior to the study. All T2 group participants were asked whether having the food safety instructions come from a celebrity chef influenced how they prepared the meal in the test kitchen. Most (81%) said no, with most citing reasons that were coded as "generally follow the recipe anyway" and

"being a celebrity chef does not necessarily equate to expertise in food safety." Forty-six percent of T2 participants had seen food safety instructions shared before by celebrity chefs. Many participants (81%) said they trusted celebrity chefs to provide information on how to cook food safely. Participants shared the following comments:

> *"Yes. I would say again … they wouldn't be where they are if they were making people sick. So they should know what they're doing."*
>
> *"So I got to say only like … I'll say Rachael Ray and Gordon Ramsay, I recognize them."*
>
> *"You know, if they made it in their house, and they made it big time in the cooking industry, I'd say probably they're doing ok."*

Table 3-18. T2 Group Participants' Response to Food Safety Instructions and Celebrity Chefs

Question	T2: Food Safety Recipes+CE %
Before today, had you heard of J. Kenji Lopez-Alt or the Food Lab?	
Yes	15% (10)
No	81% (55)
Answer unclear	4% (3)
Did having the food safety instructions come from a celebrity chef influence how you prepared the meals today?	
Yes	19% (13)
Celebrity equals expertise in food safety	69% (9)
No explanation or unclear	31% (4)
No	81% (55)
Generally follow recipe anyway	45% (25)
Celebrity does not equal expertise in food safety	25% (14)
No explanation or unclear	29% (16)
Have you seen this information (i.e., food safety instructions) shared before by celebrity chefs?	
Yes	46% (31)
No	46% (31)
Answer unclear	9% (6)

(continued)

Table 3-18. T2 Group Participants' Response to Food Safety Instructions and Celebrity Chefs (continued)

Question	T2: Food Safety Recipes+CE %
Do you trust the following celebrity chefs to provide information on how to cook food safely?[a]	
Yes	81% (55)
No	9% (6)
Answer unclear	10% (7)
Do you ever search for recipes online?	
Yes	93% (63)
No	7% (5)
(If yes) When searching for recipes online, do you seek out recipes from celebrity chefs? (*n* = 63)	
Yes	32% (20)
No	65% (41)
Answer unclear	3% (2)
(If yes) Rate how strongly you agree/disagree with this statement: I follow food safety instructions because a celebrity chef endorsed them (*n* = 20)	
Disagree	55% (11)
Neutral	10% (2)
Agree	35% (7)
Number of participants (unless otherwise noted)	68

[a] Participants were asked about their trust in several specific well-known celebrity chefs, including Rachael Ray, Rhee Drummond, Ina Garten, Gordon Ramsey, Jamie Oliver, Martha Stewart, and Jose Andres.

Most participants (93%) have searched for recipes online. Among these participants, 32% seek out recipes from celebrity chefs when searching online for recipes. Among participants who do seek out recipes from celebrity chefs when searching online (*n* = 20), over half disagreed with the statement "I follow food safety instructions because a celebrity chef endorsed them." Participants shared the following comments:

> *"No, they don't really wash their hands that much."*

> *"Not really. Their job is to entertain."*

4. Conclusion

This section concludes the report by summarizing the key findings from the meal preparation experiment and discussing implications for message development that FSIS OPACE may want to consider.

4.1 Impact of Intervention (Control vs. T1 and Control vs. T2)

In 2019, the PFSE (2020) released a Food Safety Style Guide, providing guidance for incorporating food safety recommendations and handling instructions for people writing recipes. The release of this guidance was due in part to recent consumer research. Maughan et al. (2016) assessed whether food safety instructions in recipes improved consumer food safety behavior when preparing chicken breasts and ground turkey patties; handwashing and thermometer use were significantly improved in consumers who received the recipes with food safety instructions compared with those who did not. Participants also stated that they were likely to use recipes with food safety instructions in the future if available.

The recipes used for the treatment groups used food safety instructions based on the style guide developed by the PFSE. Additionally, the recipes for T2 were endorsed by a celebrity chef. The results of this study suggest that the inclusion of food safety instructions in the recipes influenced certain food handling behaviors observed in the kitchen as described below.

- ***Thermometer use.*** About 95% or more participants in both treatment groups used a food thermometer to check doneness compared with 55% (bratwurst) and 58% (hamburgers) of control group participants.
- ***Handwashing before meal preparation.*** Nearly two-thirds of participants in both treatment groups attempted handwashing before meal preparation compared with 44% of control group participants.
- ***Cleaning and sanitizing surfaces.*** Immediately after handling the chub, 53% of T1 participants attempted cleaning/sanitizing of the surface used to prepare the chub compared with 31% of control group participants. The rate was also higher for T2 participants (46%), but the difference was not statistically significant.
- ***Cross-contamination.*** Based on the results of the microbiological analysis, for the sink basin the prevalence of contamination was higher for the control group (32%) compared with T1 (17%). The prevalence rates for T1 and T2 were also significantly different.

In the post-observation interviews, many participants reported cooking from a recipe, and most participants in both treatment groups reported that they noticed the food safety instructions in the recipes.

Inclusion of food safety instructions in the recipes did not appear to influence handwashing attempts during meal preparation for required handwashing events, attempting to clean and sanitize the surface used to prepare the chub at the end of meal preparation (if not

previously cleaned/sanitized), and the prevalence of contamination for the salad lettuce and other kitchen surfaces sampled. Also, the inclusion of instructions did not appear to influence proper washing of the carrot and apple for the salad (i.e., rubbing under cold water), although the rate of attempting washing was higher among the two treatment groups compared with the control group.

4.2 Impact of Celebrity Chef Endorsement (T1 vs. T2)

Recognition of the celebrity chef featured in the second treatment group was low (15%). Thus, it is not surprising that any differences observed between T1 and T2 were not statistically significant, with the exception of prevalence of contamination for one surface (sink basin). About 81% of T2 participants said they trust celebrity chefs (the question asked about more mainstream chefs) to provide information on how to cook food safely; however, only 35% of participants agreed with the statement "I follow food safety instructions because a celebrity chef endorsed them." Most T2 participants look online for recipes, but only 35% said they seek out recipes specifically from celebrity chefs. These findings suggest that the addition of a celebrity chef endorsement for food safety instructions in recipes may not influence consumers' food safety behaviors and that inclusion of food safety instructions alone may be sufficient to motivate behavior change.

These results highlight the importance of timing in disseminating food safety information to consumers. Prompting consumers at the time of meal preparation and as part of the recipe positions consumers to follow recommended food safety instructions, even if it is not their usual practice. Additionally, the Food Safety Style Guide could serve as a useful reference point for media organizations when producing news segments about food safety (e.g., including examples of specific safe handling instructions).

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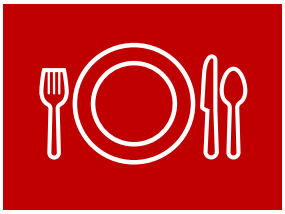
Appendix A:
Recipes

Control Group

WHAT YOU NEED:

- ½ onion
- ½ lb. ground beef
- ¼ tsp chili powder
- ½ tsp cumin
- ¼ tsp salt
- ½ tsp black pepper
- 1 package of bratwurst



SPICY BURGERS AND BRATS

STEP 1 Dice onion into little pieces.

STEP 2 Combine ½ pound ground beef, onions, and seasonings in bowl and mix.

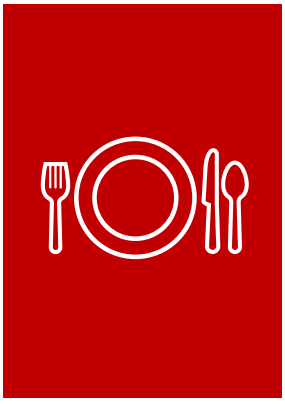
STEP 3 Form into 2 patties.

STEP 4 Grill burgers and brats to your desired level of doneness.

STEP 5 As burgers and brats cook, prepare salad.

WHAT YOU NEED:

- 1 apple
- 1 medium carrot
- 1 of bag of salad



GREEN APPLE AND CARROT SALAD

STEP 1 Slice apple and cut into bite-sized pieces.

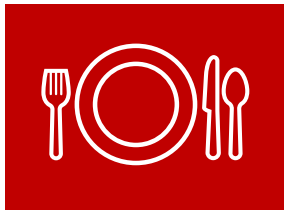
STEP 2 Dice carrot into bite-sized pieces.

STEP 3 Combine in bowl with the bagged salad.

Treatment 1 Group

WHAT YOU NEED:

- ½ onion
- ½ lb. ground beef
- ¼ tsp chili powder
- ½ tsp cumin
- ¼ tsp salt
- ½ tsp black pepper
- 1 package of bratwurst



SPICY BURGERS AND BRATS

STEP 1 Wash hands with soap and water.

STEP 2 Dice onion into little pieces.

STEP 3 Combine ½ pound ground beef, onions, and seasonings in bowl and mix. Do not wash or rinse raw meat.

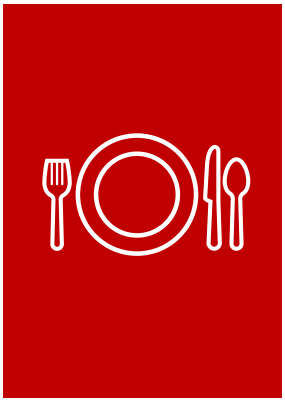
STEP 4 Form into 2 patties. Wash hands with soap and water after handling uncooked ground beef. Clean and then sanitize the counter and utensils after touching uncooked ground beef.

STEP 5 Grill burgers and brats until internal temperatures reaches 160°F on food thermometer.

STEP 6 As burgers and brats cook, prepare salad.

WHAT YOU NEED:

- 1 apple
- 1 medium carrot
- 1 of bag of salad



GREEN APPLE AND CARROT SALAD

STEP 1 Wash hands with soap and water.

STEP 2 Gently rub apple under cold running water, and dice into bite-sized pieces.

STEP 3 Gently rub carrots under cold water, then dice into bite-sized pieces.

STEP 4 Combine in bowl with the bagged salad.

Treatment 2 Group

KENJI'S SPICY BURGERS AND BRATS

WHAT YOU NEED:

- ½ onion
- ½ lb. ground beef
- ¼ tsp chili powder
- ½ tsp cumin
- ¼ tsp salt
- ½ tsp black pepper
- 1 package of bratwurst

MEET THE **CHEF!**

J. Kenji Lopez-Alt is a food columnist for the New York Times, co-owner of Wursthall, a German-inspired California beer hall, Chief Culinary advisor to Serious Eats, and author of *The Food Lab: Better Home Cooking through Science*, a New York Times Bestseller and winner of the James Beard Award for General Cooking.

STEP 1 Wash hands with soap and water.

STEP 2 Dice onion into little pieces.

STEP 3 Combine ½ pound ground beef, onions, and seasonings in bowl and mix. Do not wash or rinse raw meat.

STEP 4 Form into 2 patties. Wash hands with soap and water after handling uncooked ground beef. Clean and then sanitize the counter and utensils after touching uncooked ground beef.

STEP 5 Grill burgers and brats until internal temperature reaches 160°F on food thermometer.

STEP 6 As burgers and brats cook, prepare the salad.

KENJI'S GREEN APPLE AND CARROT SALAD

WHAT YOU NEED:

- 1 apple
- 1 medium carrot
- 1 of bag of salad

MEET THE **CHEF!**

J. Kenji Lopez-Alt is a food columnist for the New York Times, co-owner of Wursthall, a German-inspired California beer hall, Chief Culinary advisor to Serious Eats, and author of *The Food Lab: Better Home Cooking through Science*, a New York Times Bestseller and winner of the James Beard Award for General Cooking.

STEP 1 Wash hands with soap and water.

STEP 2 Gently rub apple under cold running water, and dice into bite-sized pieces.

STEP 3 Gently rub carrots under cold water, then dice into bite sized pieces.

STEP 4 Combine in bowl with the bagged salad.

MEET THE CHEF

J Kenji López-Alt is the author of *The Food Lab: Better Home Cooking through Science*, a New York Times best-seller and winner of the James Beard Award for General Cooking. He is also the Chief Culinary Advisor for Serious Eats, an award-winning and leading resource for thoroughly tested recipes that work, in-depth explanations of cooking techniques—and the science behind them!—and detailed reviews of cooking equipment.

López-Alt is also chef (and a partner) at Wursthall, a German-inspired beer hall and restaurant located in San Mateo, California and has been featured on several shows and podcasts including The Burger Show, The Food Lab, Guy's Grocery Games, Christopher Kimball's Milk Street, and The Splendid Table.

Appendix B:
Observation Script

Check-In Script—English

Welcome! My name is _____ and I'll be walking you through what you'll be doing as part of our study today.

Today, you will be preparing burgers made from ground beef, brats, and a side salad to help us test recipes for a new cookbook.

We will interview you after you finish cooking. The cooking and interview will last no longer than 2 hours.

Observation Script (Control and Treatments (not the Guac Group)

Pre-cooking Script

Before we start, I need you to read and sign the consent form.

Please let me know if you have any questions or concerns.

After Consent Form Is Signed

Today, you will be preparing ground beef burgers, brats, and a side salad.

Please do not eat any of the food or take any home with you. We will interview you after you are finished cooking. The cooking and interview will last up to 2 hours.

This is the area where you will be cooking. Here's the grill for cooking the burgers and brats. If you are unfamiliar with this type of grill, here are the instructions. All the available utensils and dishes are in these drawers/cabinets. [Note: open a few cabinets and drawers and be sure to open the drawer with the thermometer, materials for repackaging, and cleaning/sanitizing solution].

The ground beef, brats, and the apples, carrots, and lettuce for the salad are in the refrigerator. Here are the recipes (provide formatted recipes).

Please prepare the burgers and brats first and the salad as the meat cooks. You only need to use half of the ground beef today, so please repackage the remaining ground beef as you would at home. Materials you may need for repackaging are located here [point] in the kitchen.

After you are done cooking, please clean up as you would at home. You can load the dishwasher, but please do not turn it on. Also, please do not clean the grill. We will take care of that for you.

Feel free to use whatever you need. Please make yourself at home; you are welcome to use your phone to listen to music or whatever you usually do when cooking at home. If the temperature of the kitchen is not okay, let me know and I can adjust it.

Restrooms are located _____, and in case of an emergency, the exits are _____. The fire extinguisher is located _____ and the first aid kit is located _____.

Before you begin, do you have any questions?

If you have any questions or concerns while you're cooking, I will be in the _____ room.

[After food preparation]

Now that you have finished the cooking portion of the study, we are ready to begin the interview. It should take about 20 minutes to complete. Do you need a break before we begin that portion?

Observation Script (Guacamole group)

Pre-cooking Script

Before we start, I need you to read and sign the consent form.

Please let me know if you have any questions or concerns. You will receive a copy of the form to take home.

After Consent Form Is Signed

Today, you will be preparing ground beef burgers, brats, a side salad, and guacamole.

Please do not eat any of the food or take any home with you. We will interview you after you are finished cooking. The cooking and interview will last up to 2 hours.

This is the area where you will be cooking. Here's the grill for cooking the burgers and brats. If you are unfamiliar with this type of grill, here are the instructions. All the available utensils and dishes are in these drawers/cabinets. [Note: open a few cabinets and drawers and be sure to open the drawer with the thermometer, materials for repackaging, and cleaning/sanitizing solution].

The ground beef, brats, the apples, carrots, and lettuce for the salad, and the cilantro for the guacamole are in the refrigerator. The avocadoes, lime juice, and onion for the guacamole are here on the counter. Here are the recipes (provide formatted recipes).

Please prepare the burgers and brats first and the salad and guacamole as the meat cooks. You only need to use half of the ground beef today, so please repackage the remaining ground beef as you would at home. Materials you may need for repackaging are located here [point] in the kitchen.

After you are done cooking, please clean up as you would at home. You can load the dishwasher, but please do not turn it on. Also, please do not clean the grill. We will take care of that for you.

Feel free to use whatever you need. Please make yourself at home; you are welcome to use your phone to listen to music or whatever you usually do when cooking at home. If the temperature of the kitchen is not okay, let me know and I can adjust it.

Restrooms are located _____, and in case of an emergency, the exits are _____. The fire extinguisher is located _____ and the first aid kit is located _____.

Before you begin, do you have any questions?

If you have any questions or concerns while you're cooking, I will be in the _____ room.

[After food preparation]

Now that you have finished the cooking portion of the study, we are ready to begin the interview. It should take about 20 minutes to complete. Do you need a break before we begin that portion?

Appendix C:
List of Equipment Provided in Each Test Kitchen

This picture shows one of the test kitchens used for the meal preparation experiment. The equipment provided in each test kitchen is listed below.

Kitchenware

Countertop Grill

Skillet

- Medium-sized skillet (9–12 inch)

Frying pans (store frying pans in the cabinets)

- Small (8 inch) nonstick
- Medium or large (10–12 inch)

Saucepans

- Small (2–3 quarts)
- Medium or large (4–5 quarts)

Knives

- Chef's knife
- Paring knife/fruit knife

Baking dishes

- 9 x 13 baking dish (rectangular)
- Smaller square, rectangular, or oval baking dish

Utensils

- Wooden or plastic stirring spoons (1–2)
- Heat-resistant plastic or silicone spatula
- Slotted spoon
- Ladle
- Flat spatula
- Cooking tongs
- Digital tip-sensitive instant read thermometer
- Dry measuring cups
- Liquid measuring cup (1 cup)
- Measuring spoons
- Can opener
- Liquid measuring cup (2 cup)
- Whisk
- Rolling pin
- Peeler
- Zester/grater
- Large cutting boards
- Splatter guard
- Serving bowl
- Serving utensils (serving fork, spoon, and tongs)
- Salt and pepper shaker (must be glass)
- Garlic and onion powder
- Utensil holder

Other essential tools

- Small, medium, and large mixing bowls
- Colander
- Salad spinner

Silverware/dinnerware

- Set of spoons, knives, and forks
- Dinner plates
- Salad plates
- Bowls

Cleaning/dishwashing supplies

- Kitchen towels
- Dish cloths
- Hand soap
- Dish drain board/dish rack
- Paper towels
- Sponge
- Sponge caddy
- Paper towel holder
- Apron
- Oven mitts
- Pot holders
- Dishwashing detergent

Cleaning items for under sink

- Windex
- Clorox bleach
- 409 cleaner
- Lysol spray

Leftover kit supplies

- Ziploc bags (gallon and quart sizes)
- Plastic wrap
- Plastic containers with lids

Note: Containers must be sanitized between observation events. Ziploc bags and plastic wrap must be taken out of retail packaging and placed in kitchen drawers.

Housekeeping items

- First-aid kit
- Toolbox

Food

Recipe card

- Double-sided, laminated card

Ingredients

- 1 pound chub package
- Bratwurst
- Apples
- Carrots
- Bagged salad
- Onion
- Spices

Appendix D:
Microbiological Methods

D.1 DH5-Alpha Stock Selection and Preparation

In the second year of the annual FSCRP study, NCSU's microbiology team provided scientific justification for using a nonpathogenic *Escherichia coli* strain, tagged with green fluorescent protein (GFP) (*E. coli* DH5-Alpha), as a surrogate for pathogenic *Salmonella* in whole chicken pieces, with the approval of OPHS. For the grilling study, we used the same nonpathogenic *E. coli* strain as a surrogate for pathogenic *E. coli*, such as O157, found in ground beef and inoculated ground beef packaged in chub-like bags, which was also approved by OPHS. A GFP and kanamycin resistance gene were contained in the pBIT plasmid that would allow the differentiation of bacterial contamination from improper handling of the ground beef and any other naturally present *E. coli* or kanamycin-resistant bacteria. A DH5-Alpha colony with pBIT will fluoresce green under ultraviolet light (UV) and be easily identifiable compared with a colony from a bacteria that is naturally occurring and not indicating cross-contamination.

The DH5-Alpha was obtained and frozen in an 80/20 trypticase soy broth kanamycin (30 ug/mL)/glycerol stock at −80 C. When used for inoculation, one loopful of the frozen stock was placed in the appropriate amount of trypticase soy broth with 30 ug/mL of kanamycin and mixed. The bacteria was then incubated, shaking overnight at 37°C aerobically. The culture was also streaked directly onto trypticase soy agar with kanamycin (TSA Kan30), incubated upside down aerobically at 37°C, and visualized under UV light to validate that the stock still had an active pBIT plasmid.

D.2 Ground Beef Inoculation

Inoculation was performed by mixing a prepared culture of the surrogate with a specified weight of ground beef in a Kitchen Aid mixer. Two pounds of ground beef were used for each meal preparation event, and ground beef was inoculated with the surrogate twice a week to keep the bacterial concentration high and keep the ground beef within its shelf life. The surrogate was cultured overnight, shaking at 37°C in a trypticase soy broth with kanamycin. The surrogate was then spun down at 3000 *x* g for 15 minutes at 4°C. The supernatant was then poured off and the pelleted surrogate was resuspended in 0.1% buffered peptone water (BPW). Two pounds of ground beef, purchased no more than 24 hours prior to preparation, were then placed into the mixing bowl of a Kitchen Aid mixer with 40 mL of resuspended surrogate and mixed for a minimum of 2 minutes. Ground beef was then packaged similarly to commercially available chubs in chub-like bags and sealed with a metal hog ring on one end. After packaging, the chubs were transported to the test kitchens where they were stored at 4°C and used within 4 days.

D.3 Inoculation Validation

Periodically, extra ground beef was inoculated on inoculation days to ensure the inoculation process remained consistent. This ground beef was not packaged but instead processed for enumeration of the surrogate. Following inoculation, a 25-g aliquot of ground beef was added to 50 mL of 0.1% BPW and stomached for 1 minute at 260 rpm. The liquid was serially diluted and plated on TSA Kan30 and incubated upside down overnight at 37°C aerobically. Colonies were counted and visualized under UV light, and an average of the surrogate per 1 g of ground beef was determined (consistently 7 $\log_{10}$ CFU/gram of ground beef).

D.4 Environmental Sampling and Lettuce Collection

Environmental sampling was performed to assess cross-contamination that occurred during meal preparation. Pur-Blue swabs in Letheen broth (World Bioproducts, Libertyville, IL) were used to sample the kitchen surfaces, and an aliquot of 25 g of the lettuce from the RTE salad was collected in a Ziplock bag for each meal preparation event. Irregular surfaces were swabbed entirely, while flat surfaces were swabbed using a 100-cm^2 template.

D.5 Detection and Quantification of DH5-Alpha on Environmental Samples and Lettuce

The environmental samples were analyzed at an NCSU lab within 24 hours. The samples were kept at 4°C until they were processed. The outside of the swabs was wiped down with ethanol to remove any kitchen surface contamination. The swabs were vortexed for 15 seconds, and then tenfold dilutions were made for each swab using 9 mL of 0.1% BPW. The samples were briefly vortexed to mix, and then 100 uL were plated in duplicate for each swab per dilution onto TSA Kan30 plates, and then incubated aerobically upside down at 37°C for 24 hours. The samples were examined under UV light, and glowing colonies were counted as a positive result. The counts were adjusted for total volume and dilution and recorded.

For the lettuce sample, 25 g were weighed into a filtered WhirlBag and stomached at 260 rpm for 1 minute with 50 mL 0.1% BPW. Tenfold serial dilutions were prepared in 9 mL of 0.1% BPW and vortexed briefly to mix. 100 uL of the dilutions were plated on TSA Kan30 plates and incubated aerobically upside down at 37°C for 24 hours. The samples were examined under UV light, and glowing colonies were counted as a positive result. The counts were adjusted for total volume and dilution and recorded.

D.6 Sanitation After Meal Preparation Event

We sanitized the kitchens following meal preparation in accordance with NCSU's guidelines for sanitizing laboratory work surfaces, a requirement of the university, with additional requirements because of COVID-19. We applied household bleach diluted to a 10%

concentration to hard surfaces with a contact time of 60 seconds before wiping them clean with a disposable paper towel. We repeated this step twice for a total of three sanitation steps. The efficacy of this sanitation procedure was confirmed during in-lab optimization studies and the pilot conducted in the test kitchen. A cleaning validation swab sample was also taken at the beginning of all meal preparation observations, and if a cleaning validation sample showed signs of remaining contamination on kitchen surfaces, samples for that particular observation were excluded from data analysis. All utensils (e.g., knives, cutting boards, and bowls) were cleaned in dishwashers.

Appendix E:
Post-observation Interview Guide

FSCRP YEAR 4

OMB Control Number: 0583-0169
Expiration date: 08/31/2023

Introduction Script

Thank you so much for your time today and allowing us to record your actions while you prepared a meal just like you would in your home. Now I would like to ask you a few follow-up questions that will focus on some of the activities you participated in while in the model kitchen.

Is it okay with you if I record your answers? The recording is confidential and will only be used to accurately capture our conversation (allowed recording y/n).

If it is okay with you, I'd like to begin this interview, which will take about 20 minutes. If **no**: Terminate interview.

If **yes**: Proceed.

Observation Follow-Up (use trigger form for context)

E.1 Handwashing

Did you **wash your hands before you started cooking** today? Can you tell me why you did/did not wash your hands?

Is that something you usually do when cooking at home? Why?

At what other points did you wash your hands when cooking today?

Are there times when you know you should wash your hands, but you do not? Why?

When you touch food, when do you wash your hands? Why those times? [Probe if not mentioned: Does the decision to wash your hands vary by the type of food?]

What role do government recommendations play in whether you wash your hands or not?

Has COVID-19 played a role in how often or when you wash your hands? If yes, how?

E.2 Food Thermometer

How did you determine the **doneness of the burgers and brats** today? [Probe if not mentioned: Was it the same or different for the two types of meat? Why?]

Is that how you usually determine doneness of meat when cooking at home? Why?

[If used thermometer] Do you usually use a food thermometer when grilling at home? For which foods? Why?

[If used thermometer] Why do you use a food thermometer? [Probe if no reason is given for using a food thermometer: Is this something your family does? Is it a recommendation you saw somewhere?}

[If used thermometer] How did you check the temperature with the food thermometer? How did you insert it into the food?

E.3 Burger Prep/Cooking and Salad Prep

Can you walk me through how you typically make the hamburger patties, transfer them to the grill, then off the grill and ready to be served at home? Did you do anything different today?

Today we told you what order to cook the foods. If you were grilling out at home, which would you do first: grill the meat or make the salad? Why?

E.4 Repackaging Unused Ground Beef

Today we instructed you to use only half of the ground beef and to repackage the remaining ground beef. Tell me how you did this today.

Do you ever buy large quantities of meat or poultry with the plan to use part of it for a meal and to store the rest?

Now, let's assume you purchased a large quantity of ground beef with the plan to use part of it for a meal and to store the rest. How would you open the package and separate out the meat for use in the meal versus the meat to repackage for storage?

When would you store the ground beef not used for the meal: at the end of meal preparation or some other time? (Probe: after coming home from the grocery store in advance of when you would actually cook it or during/after meal preparation after you've separated out what you will cook at that time)

What steps would you take to store the ground beef you were not planning to use at that time?

What would you put the unused ground beef in? [Probe if necessary: plastic container, plastic or freezer bag, wrap plastic wrap over the chub package, butcher paper, aluminum foil]

How would you clean up after storing the unused ground beef?

[If not mentioned] What about washing your hands?

Would you label the unused ground beef in some way? If so, how would you label it and why? If not, why not?

E.5 Cleaning/Sanitizing

Can raw brats spread germs to other food in your kitchen? Why? What about other surfaces? Why do you think that?

Assume you were preparing brats at home, can you walk me through how you would usually clean up?

[If not mentioned] What about sanitizing, for example, using chlorine bleach or another sanitizer? What would you use and how would you use it?

[If not mentioned before]: Has COVID-19 played a role in how often or when you clean or sanitize? If yes, how?

For the meal you prepared today, what else might spread germs?

E.6 Preparation of Guacamole (for the 50 participants not included in experiment)

Tell me how you prepared the guacamole from beginning to end.

[If not mentioned] What about **washing the avocados** before you cut them: is this something you did or did not do?

[If yes] Why did you wash them? What were you trying to accomplish?
[If no] Why didn't you wash them?

[If yes] How did you wash the avocados? [Probe: rinse under running water, rub with hands, scrub with a brush, soak in water]

[If yes] Did you wash your hands after washing the avocados?

FDA advises consumers to wash their avocados before peeling them. Before today, were you aware of the need to wash avocados before cutting them?

[If not mentioned] What about **washing the cilantro** before you chopped it: is this something you did or did not do?

[If yes] Why did you wash it? What were you trying to accomplish?

[If no] Why didn't you wash it?

[If yes] How did you wash it? [Probe: rinse under running water, soak in water]

Have you heard of any germs that make people sick associated with avocado or cilantro? [If yes] What bacteria?

E.7 Questions about Intervention—Treatment Groups Only

Do you usually cook from a recipe?

Did you notice the food safety instructions in the recipes today? [If necessary: For example, the recipe stated, "Wash hands with soap and water" and "Grill burgers until internal temperature reaches 160°F on food thermometer."]

Have you ever noticed food safety instructions like these in recipes before? Where?

[Treatment Group 1: Instructions with Food Safety Only]

Did the food safety instructions influence how you prepared the meal today?

[If yes] In what way? [Probe: specific food safety instruction and food]

[If no] Why not?

Do you think reading food safety practices included in recipes would affect how you prepare food at home in the future?

[If yes] In what way? [Probe: specific food safety instruction and food]

[If no] Why not?

Is there any additional food safety instruction you would add to the recipes?

[Treatment Group 2—Instructions with Food Safety and Celebrity Chef]

Before today, had you heard of J. Ken i Lopez-Alt or the Food Lab?

[If yes] Have you prepared any of his recipes before?

Did the food safety instructions influence how you prepared the meal today?

[If yes] In what way? [Probe: specific food safety instruction and food]

[If no] Why not?

Do you think reading food safety practices included in recipes would affect how you prepare food at home in the future?

[If yes] In what way? [Probe: specific food safety instruction and food]

[If no] Why not?

Is there any additional food safety instruction you would add to the recipes?

What are your thoughts on having a celebrity chef include food safety instructions in his recipes? Have you seen this information shared before by celebrity chefs?

Did having the food safety instructions come from a celebrity chef influence how you prepared the meal today? Why? Does having this information coming from a chef make it

more likely for you to follow it at home? (prompt, information such as "be sure to use a thermometer to cook the burgers to 160F)

Would you say that this chef an expert in cooking food safely?

Rate your level of trust in his ability to provide safe food handling information Likert 1–5, five being very high trust, 1 being untrustworthy)

Do you trust the following celebrity chefs to provide information on how to cook food safely:

- Rachel Ray
- Rhee Drummond (Pioneer Women)
- Ina Garten (Barefoot Contessa)
- Gordon Ramsay
- Jamie Oliver
- Martha Stewart
- Jose Andres

Do you ever search for recipes online?

[If no] ***Go to Section 1.8 Conclusion***

[If yes] When searching for recipes online, do you seek out recipes from celebrity chefs?

[If yes] Which celebrity chefs?

[If yes] How much do you agree with the following statement: I follow food safety instructions because a celebrity chef endorsed them. (1 being that you strongly disagree, 7 being that you strongly agree)

E.8 Conclusion

We mentioned in our recruiting materials that we were interested in testing new recipes. However, the specific focus of our study is on food safety and how to prevent food poisoning. We purposely did not tell you exactly what our specific research objectives were in advance so that we could capture your behaviors in a natural way. In addition, a biological tracking agent was in the food to help us track where contamination might occur. This biological tracking agent was harmless bacteria called *Escherichia coli* (*E. coli*) K12 DH5-Alpha, it does not pose any health hazard to you, and has been approved for use in this study by the Division of EHS and the Institutional Review Board at NCSU. Part of its name may sound familiar because it is a harmless cousin of *E. coli* O157. There are hundreds of strains of *E. coli*, many are needed for our gut system to work correctly and are not able to make us ill. *E. coli* DH5-Alpha doesn't have the genes that cause disease that *E. coli* O157 does, which is why the second part of their names are different. This makes *E. coli* DH5-Alpha non-pathogenic, non-toxic, and safe for humans to handle. You can request to

be removed from the study at any time, and if you decide to exit the study at this point, we will destroy the recordings of your actions, and you will not be included in the data set.

We want to confirm with you now that you understand the focus of our study and that you wish to remain as a participant.

If **no**: Thank you so much for your time; we will remove your data from our data set and destroy any records.

If **yes**: Thank you for your consent.

Thank you again for your time and for your participation in our study today.

Please see the greeter on your way out to receive the $75 gift card and gift.

Appendix F:
Screening Questionnaire[8]

Screen 1

Thank you for your interest in our research study, which is funded by the U.S. Department of Agriculture and conducted by researchers from North Carolina State University and RTI International.

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0583-0169 and the expiration date is 8/31/2023. The time required to complete this information collection is estimated to average 8 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Screen 2

If you are eligible for the study on recipe testing, you will be asked to prepare a meal while being videotaped and to participate in an interview. The study will last up to 2 hours, and you will receive a $75 gift card and a small gift for taking part in the study.

To determine whether you are eligible, you will need to answer a few questions. These questions will take less than 10 minutes to complete. Your participation in this study is completely voluntary. All of your answers and your contact information will be kept private. Please click the ">>" arrows below if you would like to continue.

Question Screens

1. Have you cooked or worked professionally in a food preparation setting in the past 5 years?
   - ☐ Yes → ***Ineligible. Terminate.***
   - ☐ No

2. Have you received any type of food safety training, such as ServSafe, in the past 5 years?
   - ☐ Yes → ***Ineligible. Terminate.***
   - ☐ No

3. Have you participated in any research studies about cooking in the past 4 years?
   - ☐ Yes → ***Ineligible. Terminate.***
   - ☐ No

[8] Web version shown; a telephone version was also available for people who called in to be screened.

4. Do you have any children living in your household who are less than 18 years of age?
   - ☐ Yes
   - ☐ No

5. Which of the following foods have you cooked outdoors using a grill, barbecue, or other cooking tool during the past 6 months?
   - ☐ Vegetables
   - ☐ Fish
   - ☐ Poultry
   - ☐ Steak
   - ☐ Pork (for example, ribs or chops)
   - ☐ Hot dogs
   - ☐ Bratwurst, brats, or Italian sausages
   - ☐ Ground beef burgers → ***If not selected, ineligible. Terminate.***
   - ☐ None of the above

6. Have you purposefully purchased meat or poultry in large quantities with the plan to repackage it for cooking at a later date?
   - ☐ Yes
   - ☐ No

7. During the past 3 months, about how often did you purchase ground beef that is not sold in Styrofoam trays? This type of packaging is sometimes referred to as a chub. Chubs are a tube-like package that looks like a sausage with the ends sealed by metal crimps or clips.
   - ☐ Never → ***Go to Question 9.***
   - ☐ 1 to 3 times
   - ☐ 4 to 6 times
   - ☐ 7 to 12 times
   - ☐ More than 12 times

8. Why do you purchase ground beef that is not sold in Styrofoam trays (chubs)? Please select one or more.
   - ☐ Price
   - ☐ Convenience
   - ☐ Shelf life
   - ☐ Size options
   - ☐ Brand preference (i.e., that's how the brand you like packages their products)
   - ☐ Other

9. Do you have experience cooking with avocado (cutting and mashing whole avocado)?
   - ☐ Yes
   - ☐ No → ***Ineligible for subset.***

10. Do you have experience cooking raw or fresh bratwurst or sausages purchased at a meat counter that are not pre-cooked or smoked?
    - ☐ Yes
    - ☐ No

11. When cooking a food product at home for the first time, how often do you read the cooking instructions on the package before you start cooking?
    - ☐ Always
    - ☐ Most of the time
    - ☐ Sometimes
    - ☐ Hardly ever
    - ☐ Never

12. Which of the following items do you have in your kitchen? *(Select all that apply.)*
    - ☐ Chef's knife
    - ☐ Garlic press
    - ☐ Citrus zester
    - ☐ Food thermometer
    - ☐ Manual can opener
    - ☐ Vegetable peeler
    - ☐ Cheese grater
    - ☐ Wine opener
    - ☐ None of the above

13. Do you identify as …?
    - ☐ Female
    - ☐ Male
    - ☐ Other
    - ☐ Prefer not to answer

14. Are you …?
    - ☐ Hispanic or Latino
    - ☐ Not Hispanic or Latino

15. What is your race? Please select one or more.
    - ☐ American Indian or Alaska Native
    - ☐ Asian
    - ☐ Black or African American
    - ☐ Native Hawaiian or Other Pacific Islander
    - ☐ White

16. What is your age?
    - ☐ Under 18 → ***Ineligible. Terminate.***
    - ☐ 18 to 34
    - ☐ 35 to 54
    - ☐ 55 to 64
    - ☐ 65 to 75 → ***Ineligible. Terminate***
    - ☐ 76 or older → ***Ineligible. Terminate***

17. What is the highest level of education that you have completed?
    - ☐ Less than high school
    - ☐ High school graduate or GED
    - ☐ Technical or vocational school
    - ☐ Some college, but did not get a degree
    - ☐ 2-year associate's degree
    - ☐ 4-year college degree
    - ☐ Postgraduate degree

18. Are you or any members of your household …? *(Select all that apply.)*
    - ☐ 65 years of age or older
    - ☐ 5 years of age or younger
    - ☐ Pregnant
    - ☐ Breastfeeding
    - ☐ Diagnosed with an allergy to any food or food ingredient
    - ☐ Diagnosed with diabetes or kidney disease
    - ☐ Diagnosed with a condition that weakens the immune system, such as cancer, HIV, or AIDS; a recipient of a transplant; or receiving treatments, such as chemotherapy, radiation, or special drugs or medications to treat these conditions
    - ☐ None of the above

19. Where did you hear about this study?
    - ☐ Facebook
    - ☐ Twitter
    - ☐ Craigslist
    - ☐ Email from a North Carolina extension program
    - ☐ Sign

    Specify location: _____
    - ☐ Other

    Specify location: _____
    - ☐ Don't know

20. Have you knowingly interacted with someone who has been diagnosed with COVID-19?

    ☐ Yes→ ***Terminate.***

    ☐ No

21. Have you been diagnosed with COVID-19 in the past 14 days?

    ☐ Yes→ ***Terminate.***

    ☐ No

22. Do you have any (one or more) symptoms of COVID-19 such as cough, fever, shortness of breath, chills, muscle pain, new loss of taste or smell?

    ☐ Yes→ ***Terminate to Covid Screen***

    ☐ No

23. Are you willing to follow all safety and sanitation procedures while participating in this study including wearing appropriate personal protective equipment?

    ☐ Yes

    ☐ No → ***Terminate***

24. Check all that apply:

    I am someone with chronic lung disease or moderate to severe asthma
    I am someone with a heart condition
    I am someone who is immunocompromised. (*This can result from cancer treatment, bone marrow or organ transplantation, immune deficiencies, poorly controlled HIV or AIDS, and prolonged use of corticosteroids and other immune weakening medications*)
    I am someone with a body mass index (BMI) of 40 or higher
    I am someone with diabetes or pre-diabetes
    I am someone with chronic kidney disease undergoing dialysis
    I am someone with liver disease

25. Thank you for taking the time to complete this survey to determine your eligibility for this study. We have determined that you are eligible to participate in the study!

    Due to the COVID-19 pandemic, there are some additional precautions we must take when you participate in the study. Please be on the lookout for an email from our research team within a few business days regarding how to prepare to come to your study session and what you should expect.

    ☐ Yes
    ☐ No → ***Terminate.***

Contact Screen 1 (if no boxes checked in question 24)

Great! Please enter your name and telephone number so that a study team member can call you and schedule an appointment for the Grilling Study at a day and time that works best for you and send you text message reminders. The study will last up to 2 hours, and you will receive a $75 gift card and a small gift for taking part in the study. Please note that additional screening for Covid-19 exposure and symptoms will occur upon arrival which may determine you ineligible at that time. If you'd like, you can download a copy of the consent form here for your review; you will also receive a paper copy upon arrival.

[ENTER NAME]

[ENTER TELEPHONE NUMBER]

[Go to Contact Screen 3]

Contact Screen 2 (if ANY boxes checked in question 24)

Great! Please enter your name and telephone number so that a study team member can call you and schedule an appointment for the Grilling Study at a day and time that works best for you. The study will last up to 2 hours, and you will receive a $75 gift card and a small gift for taking part in the study. Please note that additional screening for Covid-19 exposure and symptoms will occur upon arrival which may determine you ineligible at that time. If you'd like, you can download a copy of the consent form here for your review; you will also receive a paper copy upon arrival.

Please note that you have indicated that because of experiences you may be at risk for developing severe illness should you contract COVID-19. Participation in this research requires in-person interaction which may result in contracting COVID-19. Precautions including physical distancing, wearing PPE and cleaning and disinfection, will be taken to mitigate possible transmission of COVID-19; however, you may want to take additional personal precautions.

Contact Screen 3

Please enter your email address so we can send you a confirmation email with directions. [ENTER EMAIL ADDRESS; REQUIRE DOUBLE ENTRY FOR VERIFICATION].

☐ No Email

[If no email] Please enter your mailing address. [STREET ADDRESS, CITY, NC, ZIP]

Thank you for your time. A study team member will call you in 1 or 2 days to schedule an appointment with you.

If you have any questions about the study or scheduling, you may contact Lisa Shelley at 919-659-8254. If you have concerns about your rights as a research participant, contact North Carolina State University's Office of Research Protection at 919-515-8754 or via email at irb-director@ncsu.edu.

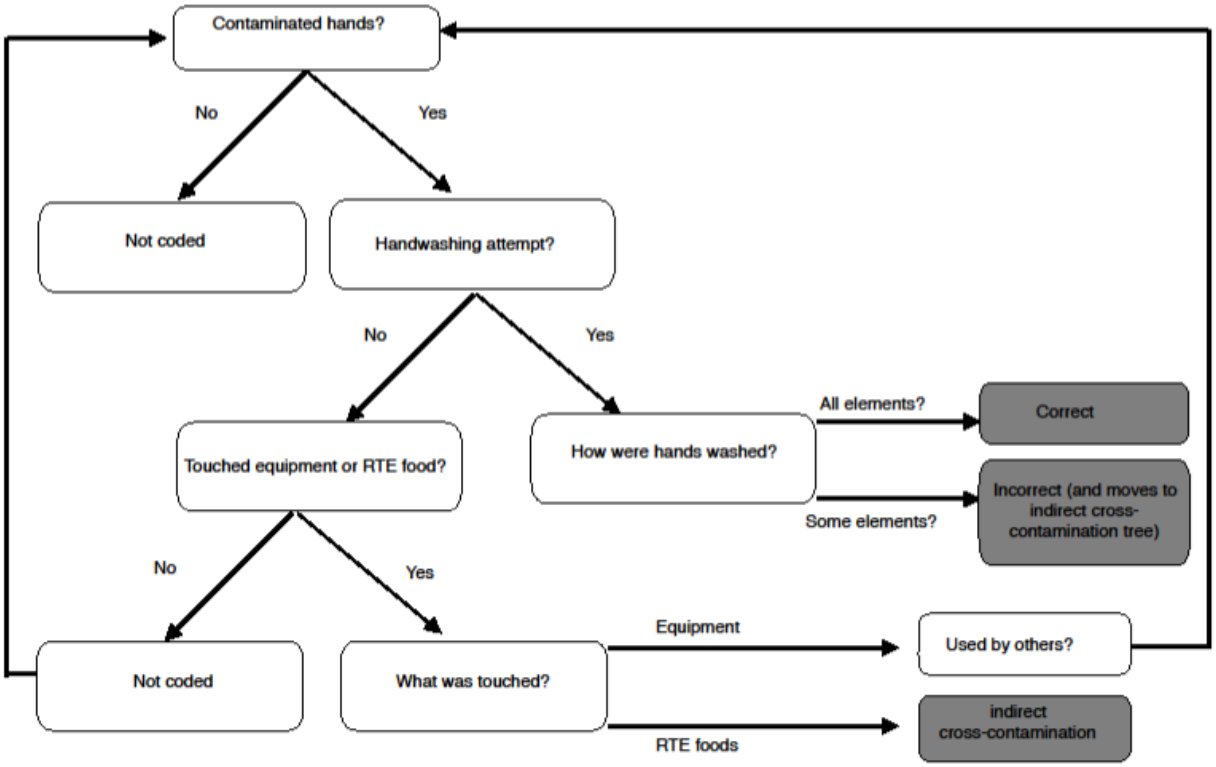
Ineligible/Covid Screen

Thank you for your time. Unfortunately, you are not eligible to take part in our study. Please contact your medical provider to discuss your needs. In addition to contacting your medical provider, if you are an NC State University employee, use this form to self-report: Employee Self-Report Form. If you are an NCSU student, please use this form to report: Student Self Report Form. If you are unaffiliated with NC State University, please call your medical provider to report symptoms.

Ineligible/Terminate Screen

Thank you for your time. Unfortunately, you are not eligible to take part in our study. Have a great day.

Appendix G:
Observation Rubric for Coding Participant Actions in the Kitchen



Notes and Definitions:

Contaminated hands: Hands that have come into contact with potentially contaminated material (raw food, contaminated equipment, touching of face or other parts of body or clothing) and that have not been washed according to CDC's recommended guidelines f or proper handwashing.

Elements of handwashing:

- Wet your hands with clean, running water (warm or cold), turn off the tap, and apply soap.
- Lather your hands by rubbing them together with the soap. Be sure to lather the backs of your hands, between your fingers, and under your nails.
- Scrub your hands for at least 20 seconds.
- Rinse your hands well under clean, running water.
- Dry your hands using a clean (one use/paper) towel or airdry them.

Source: https://www.cdc.gov/handwashing/when-how-handwashing.html

For a successful handwashing attempt, all elements should occur in the sequence listed above.